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FORWARD

This publication is Volume 3 of six volumes of the final report on Mathematical Ship Lofting and Numerical Control of Shipyard Fabricating Equipment. The work reported on herein was performed under Bureau of Ships Contract NObs-4427, Code 770, during the period from April 1961 to March 1963.

The volumes of this final report have the following titles:

- Vol. 1. Project Summary Report (Technical Report 9.0.0)
- Vol. 2. Mathematical Ship Lofting -
 - Part 1. - Theory (Technical Report 1.0.0-1)
 - Part 2. - Operating Manual (Technical Report 1.0.0-2)
- Vol. 3. Mathematical Ship Lofting - Summary Report
(Technical Report 1.5.0)
- Vol. 4. Programming System for Numerically Controlled Flame
Cutting of Ships Parts - Operating Manual
(Technical Report 5.0.0)
- Vol. 5. Development and Testing of Programming System for
Numerically Controlled Flame Cutting of Ships' Parts -
Summary Report (Technical Report 5.5.0)
- Vol. 6. Numerically Controlled Shipyard Fabricating Equipment -
Summary Report (Technical Report 3.0.0)

The work was accomplished by the Research & Development Group of the Los Angeles Division of Todd Shipyards Corporation, San Pedro, Calif. Mr. Thomas G. Smith was Project Manager for the work, and Dr. Henry A. Schade of the University of California, Berkeley, was Principal Consultant.

This report contains the results of work accomplished by the Mathematics Team which consists of:

- D. A. Atkins, Naval Architect - Mathematician (Team Supervisor)
- R. A. Tapia, Mathematician
- J. C. Fassino, Naval Architect - Mathematician
- T. A. Dunaway, Computer Programmer
- S. A. Berger, Mathematician
- W. C. Webster, Naval Architect - Mathematician
- Janice H. Thompson, Secretary

Others of the Todd Staff, whose contributions and participation during the Project were responsible for its successful culmination, consisted of:

Eric Chein, Data Processing Supervisor
R. W. Feeny, Numerical Control Engineer
H. S. Janssen, European Representative
K. M. Jones, Naval Architect
W. R. Lauper, Mechanical Engineer
M. R. Ward, Jr., Naval Architect

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ABSTRACT

The formulation for mathematically fairing curves and surfaces presented in Volume 3 of this Final Report has proved capable of economically fairing large areas of the molded form up to half the ship in size. In addition, perhaps for the first time, a satisfactory method has been developed for fairing mathematically the extreme ends where discontinuities occur. The joining of these several faired surfaces to form a single fair surface has not yet been successfully demonstrated.

The fairing method has been incorporated in a system of programs which provide loft data mathematically. Some of these programs have been used in production by Todd Shipyards Corporation and under contract to others for producing loft data.

Several elements of the fairing system require additional development work. These items are listed in the recommendations at the end of this report.

There is a need to reduce the size and density of the problem so that larger surfaces can be handled more efficiently.

Production use of the fairing method itself should be attempted only after the additional work recommended has been completed. Suggestions for the solution of these problems have been offered in this report. The effort still needed is small compared to that already expended in formulating the method itself and demonstrating the system presented.

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Section I

INTRODUCTION

Todd Shipyards Corporation, Los Angeles Division, under Contract NObs-4427 has developed and presented as Volume 3 of this final report a system for mathematically fairing and lofting ships. This system starts with the preliminary offsets produced by a naval architect and produces much of the loft data needed for construction.

The heart of this system is the mathematical fairing method presented as Part 1 - Theory, of Volume 3. This method was formulated, developed, and tested to the extent possible, within the time and funds provided.

Presented in the following sections are:

- A discussion of the mathematical fairing method employed
- The limitations of the system
- A comparison of the system with the criteria
- Recommendations and conclusions

Section II

DISCUSSION OF MATHEMATICAL FAIRING METHOD

The basic fairing method developed followed exhaustive state-of-the-art studies and comparison of the many previous approaches to the problem with the criteria established for this program. This criteria was established for the purpose of developing a method capable of meeting shipyard production requirements.

These requirements are somewhat different and definitely more restricting than the requirements for a mathematical hull definition to be used in hydrodynamic studies.

Linear programming, employing a notation for cubic equations developed by Dr. Feodor Theilheimer of the David W. Taylor Model Basin, was chosen as the best method capable of meeting the criteria.*

A. PLANE CURVE FAIRING

In applying linear programming to ship fairing, plane curves were developed first. Plane curves defined by five to twelve offsets have been faired many times. It is possible to fair curves defined by twenty or twenty-five offsets on an IBM-1620 computer using the formulation developed.

To fair a five to ten-point waterline requires only a few minutes on the 1620. Representative examples of curves and times for

* Todd Shipyards Corporation Technical Report 1.1.1, "Evaluation of Mathematical Lofting Methods in Current Use, and Comparison with Developed Criteria," R. A. Tapia, March 1, 1962

fairing are given in Appendix A.

The success of the linear programming/mathematical spline curve method for plane curves encouraged an extension of the method to three dimensions.

B. THREE-DIMENSIONAL FAIRING

The three-dimensional method used in some previous fairing schemes, and that which is most obvious because of the ease with which plane curves can be faired, is simply to fair each of the original, individual stations and waterlines independently, and iterate back and forth between waterlines and stations until at each point where a waterline and station are common, the offset from one is very nearly equal to the offset of the other.

This method was attempted but was dropped in favor of surface fairing for two reasons:

1. It had not been possible to demonstrate a set of waterlines and stations which have the same offsets at common points.
2. The surface area between stations and between waterlines is undefined. Data can only be obtained in this area by some interpolation scheme.

C. SURFACE FAIRING

The method uses surface equations rather than plane curve equations. It was first formulated under Contract NObs-4427.* The surface has the characteristics of a spline curve in the station direction and in the waterline direction.

* Ibid.

Two types of fit have been used. The first is the minimax or lambda (λ) fit. To fit the equation to the offsets using this fit, the linear program seeks to minimize the absolute value of the greatest deviation of the equation from the offsets.

The second type is the sum-of-the-deviations fit. This fit minimizes the sum of the absolute values of the individual deviations.

The difference is that the lambda fit provides an even distribution of the deviation over all the offsets. The sum-of-the-deviations fit usually provides a surface that comes very close to the majority of offsets, but may build up a large deviation at one or two offsets near one end of the surface.

The lambda fit was first formulated for linear programming using the primal tableau. It was later restated with changes using the dual tableau.

1. Lambda Formulation - Primal

The formulation required four constraints per offset. These were:

- a. The equation of the surface at each preliminary offset is equal to, or greater than, the value of the preliminary offset minus λ .
- b. The equation of the surface at each preliminary offset is equal to, or less than, the value of the preliminary offset plus λ .
- c. The value of the second difference in the waterline direction of the preliminary offset, times the value of the second derivative of the surface equation taken in the waterline direction at the preliminary offset is greater than or equal to zero.

- d. The value of the second difference in the station direction of the preliminary offset, times the value of the second derivative of the surface equation in the station direction at the preliminary offset is greater than or equal to zero.

Constraints a and b are the deviation constraints; c and d are the curvature constraints.

The first surfaces faired with this method each contained offsets for five stations and five waterlines (twenty-five offsets). These required approximately seventeen minutes of 7090 computer time to fair.* A larger surface covering ten stations and eight waterlines (eighty offsets) was then successfully faired but required an excessive amount of IBM-7090 computer time (seven hours).

At this point, it became apparent that the technique was successful from a technical viewpoint but needed to reach a solution faster for two reasons: first, to be economically feasible; second, because the great number of calculations involved could adversely affect the accuracy of the numbers involved.

2. Sum of Deviations Formulation

Experience with linear programming problems indicates that execution time of a problem varies greatly with the number of

*An example of the result of this effort is given in Appendix A of Todd Shipyards Corporation Technical Report 1.2.3, "A Method for Defining and Fairing Ships' Form Using Linear Programming," by R. A. Tapia, June 11, 1962

constraints present and varies little with the number of variables. Initial work on reducing the running time concentrated on reducing the number of constraints per offset. A variation in the formulation was made which produced the "sum of the deviations fit" reported in Part 1 - Theory, of Volume 2, of the Final Report.

Here, a single deviation constraint replaced the two deviation constraints of the λ fit. Two dummy variables were used in each constraint defined by the following:

The equation of the surface at each preliminary offset, plus the first dummy variable, minus the second dummy variable, equals the preliminary offset.

A different pair of dummy variables is used for each offset. Since these variables are linearly dependent, only one of each pair can be in the solution at a time. Therefore, the dummy variables that are in the solution are the set of deviations of the equation from the offsets. The linear program minimizes the sum of the absolute values of these deviations.

Obviously, this formulation decreases the constraints by twenty-five percent. This, plus an improvement in the manner of using the LP, produced a solution to the eighty-offset problem in sixty-two minutes instead of seven hours. The twenty-five offset problem required one minute.

3. Lambda Formulation - Dual

In an effort to retain the lambda fit but reduce the solution time, an alternate approach retaining the original four constraints was tried using a surface equation which is "double splined," as discussed in Part 1 - Theory, Volume 2, of the

Final Report. Double splining means that each cubic spans two intervals between offsets instead of one, as in previous formulations. This reduces the required number of terms in the surface equation and eliminates the curvature constraints at the offset in the center of each cubic interval. With this change, it became important to re-state the problem in the dual form. In this form the constraint matrix is transposed, and this, for the fairing formulation, presents an apparently reduced number of constraints in the problem.

The double spline formulation requires an odd number of offsets; therefore, the ten-station, eight-waterline-eighty-offset surface was replaced by an eleven-station, seven-waterline, seventy-seven offset surface. This problem, double splined in both the station and waterline directions, required seventeen minutes on the 7090. The twenty-five offset problem now required about fifteen seconds.

Because the lambda fit gives a better overall fit it has been used in the system as presented. Examples of surfaces using both fits are presented in Appendixes B and C. Deviations in all cases have been of a reasonable order compared to the unfairness one might expect in preliminary offsets - usually under one inch in surfaces and under three-eighths inch on curves.

Section III

SYSTEM LIMITATION

A. LINEAR PROGRAMMING - PROBLEM SIZE LIMITATIONS

Although there are linear programs in existence which can handle very large problems (up to 1,023 constraints), there are still practical limitations on the size, caused by two special circumstances in the ship problem:

1. The high density of the formulation, compared to other linear programming problems
2. The extreme range, from very small to very large, in number size which occurs in the matrix

The high density as well as large size of the problem matrix for a large surface requires a great many iterations and a great number of calculations per iteration. This creates long execution times for large surfaces; but more important, the excessive number of calculations, combined with the extreme range of number size, can cause a loss of accuracy. This loss can produce a surface with unacceptably large deviations from the offsets, or it can cause the program to fail to find a solution.

During the evolution of the formulation, the effects of these factors have been diminished, allowing larger and larger surfaces to be done with increased reliability. At present, the largest surface that can be faired with assurance is eleven stations by nine waterlines (ninety-nine offsets).

Several surfaces of approximately seven stations by eleven waterlines, each requiring about an hour of IBM-7090 time, must be joined to produce the complete ship molded form, for a total estimated fairing

time of four to six hours per ship. The considerations used reaching this time estimate were (1) the surfaces will be double-splined in one direction only, (2) additional time because of the uncertainty of exact solution times using linear programming. A satisfactory method of joining such surfaces has not yet been demonstrated.

There are many methods offering possibilities for increasing the size of individual surfaces defined which have not yet been tried.

Examples are:

1. To normalize each constraint within itself, thus reducing the extreme number range that can now be present
2. To perform other basic matrix arithmetic operations to reduce the size or density of the matrix
3. To investigate the possibility of fairing only every second station on selected parts of the hull.

These changes are mechanical, that is, they require no reformulation of the basic method. Such changes, coupled with improvements in linear programming methods and programs, or possibly an LP code written specifically for this problem should eventually make it possible to fair the ship molded surface complete in one pass.

B. JOINING THE FAIRED SURFACES

The problem of joining the several faired surfaces to produce a complete molded form was not attempted until near the end of the Contract period. Consequently, only one method was tried - the simplest.

This consisted of (1) fairing the first surface, (2) solving for the faired offsets at the last station of this surface, (3) overlapping the last station interval with the second surface and requiring the second surface to go exactly through the offsets found in (2). It was found that the second surface did go exactly through these points when

faired, and that on the waterlines where this happened, the difference in first and second derivatives was negligible. However, in some intervals (not all intervals) between these waterlines, the surface formed a different shaped station, causing a line of discontinuity between the surfaces so that the method was judged unsatisfactory.

Examples of other methods are:

1. Overlapping the surfaces and requiring the second surface to go through first-surface offsets of both overlapped stations
2. Overlapping the surfaces and requiring the second surface to have the same station equation as the first surface for one or both of the overlapped stations
3. Collapsing the first-surface equation into an equation for the final station interval for the first surface and requiring the second surface to have this equation in its first-station interval
4. Using decomposition programming or dynamic programming to obtain an optimum solution to the entire hull surface in stages

These methods have not been tried. Methods 1. and 2. will not provide continuous first and second derivatives at the joint, but the discrepancies may be negligible. Methods 3. and 4. have the ability to require continuous first and second derivatives. Method 3. is the easiest to implement. Method 4. uses well-established mathematical programming concepts and would provide a continuous surface equation over the entire hull.

C. FLAT BOTTOM FORMS

This horizontal surface condition leads to infinite slope in the surface equation. There are two methods for solving this problem. The first is to use the same formulation in this area as was used for the end conditions. This would allow for infinite slope, but would require a modification of the problem formulation.

A second method, more convenient to use, would be simply to require the surface to have a very large but finite slope.

Section IV

COMPARISON OF SYSTEM WITH CRITERIA

A. SYSTEM CRITERIA

The criteria established at the beginning for use in developing the fairing system, and the extent to which the fairing system meets these criteria are given below:

1. "The system should accept as data the preliminary information developed by the naval architect"

The input data required by the fairing system consists of the table of preliminary offsets, including centerplane profile data. The only additional requirement placed on the naval architect is that he extend the station lines to an imaginary waterline above the deck edge.

2. "It should include a method for eliminating gross errors in the input data"

To locate offsets which are obviously the result of an error, a computer program has been included which scans the data prior to fairing, by investigating the consistency of the signs of the second differences, along each waterline and station. If a bad offset is found, the program adjusts the value and reports both the questionable value and adjusted value to the loftsmen.

3. "It should, from the data, obtain a fully faired hull form from which the ship can be produced"

The mathematical definition of fairness used in developing the method is presented later, along with a discussion on its application. Because the molded form is described by a surface equation it is possible to describe completely intersections of other prescribed forms with it (frames, decklines, etc.). A computer program is included in the system which does this automatically.

4. "The fairing process should operate with as little human intervention as possible"

The fairing system, in its final form, should require manual effort in the initial data stages only. This effort is limited to selecting the stations which limit the extent of each surface, to preparing the input offsets, and to verifying that the smoothed offsets and second differences are consistent with the original intent. All fairing calculations from this point on are made automatically and require only the operating of the computer and someone to monitor results. However, the method has not yet been demonstrated to the extent necessary to insure its reliable application in all cases. It will therefore be necessary to evaluate surfaces produced and continue to provide the system with greater capability until such time as it can satisfactorily define all principal surfaces on all types of ships.

5. "The system should develop, as much as is practicable, complete loft information now provided by the manual loft"

The system provides the following loft data:

- a. Complete set of offsets on any station, waterline, buttock or diagonal plane at any interval
- b. Offsets along any waterline or station at any interval, such that a straight line joining two consecutive offsets comes exactly at a given tolerance from the mathematical molded form
- c. Other data as required for numerical control programs, such as slopes, curvatures, and standard cubic equations for form plane curves
- d. Mathematically developed shell plate cutting pattern offsets
- e. Offsets for plate rolling and frame bending templates
- f. Data describing the inside edge of web frames
- g. Mathematically developed offsets for longitudinal cutting patterns

B. FAIRNESS CRITERIA

System Criterion No. 3. requires the surface to be fully fair.

Mathematical criteria for fairness were established, and a comparison of the system capabilities with these criteria is presented below.

1. "The curve $Y(X)$ (which represents the intersection of a plane with the surface) must be continuous; its first derivative must be continuous; its second derivative must be continuous"

These requirements are inherently met by the spline curve representation of the surface. That is, the surface is made up of cubic equations which have continuous first and second derivatives; and these cubics are joined by a technique which guarantees these continuities across each joint.

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These requirements are inherently met by the spline curve representation of the surface. That is, the surface is made up of cubic equations which have continuous first and second derivatives; and these cubics are joined by a technique which guarantees these continuities across each joint.

2. "The curve must be completely free of unwanted inflection points while possessing those inherent in the data"

This requirement has been met by requiring the equation at each offset to have the same sign for its second derivative as the previously calculated second difference at that offset. For the surface equation, this requirement is imposed in both the station and waterline directions. This technique has been very successful in controlling inflection points wherever applied. Use of it enables the formulation to specify a choice of either one inflection point or no inflection points within each cubic interval.

3. "Deviation from scaled offsets must be as small as possible, subject to Conditions 1. and 2."

This requirement is the basic reason for the selection of linear programming to fit the surfaces, and is inherently met by it.

4. "Curves should be aesthetically pleasing"

When criteria 1 through 3 have been met by a mathematical curve or surface, experience has confirmed that Criterion 4 will also be met, provided that it was reasonably inherent in the original data.

Section V

CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The mathematical lofting system described herein has adequately demonstrated the applicability of the mathematical theory employed. It has been demonstrated that the system itself is a practical, economical one, potentially capable of providing any shipyard with all of the general information provided by conventional lofts. It is not yet a "black box" system; that is, the method has not been implemented with sufficient computer programs to permit complete lofting without some manual intervention and decisions.

The system was tested by trying to fully define only one ship. This single test showed that the system was lacking in completeness. It did not satisfactorily join individually faired surfaces, nor was it reliable in defining flat bottoms. It is apparent there is a need for additional work before the system is complete and ready for use by production forces.

The method employed in meeting the established criteria has overcome the basic problems in mathematical lofting which heretofore appeared insurmountable. It offers to the shipbuilding industry a greater potential for economical use of numerically controlled fabrication processes. If used early in the design phase, it offers the architect the potential for employing automated drawing machines in his daily work.

B. RECOMMENDATIONS

Though the method employing linear programming to fit a fair surface to the naval architect's offsets has been demonstrated as practical and economically feasible, the only full ship test which time permitted to be made proved that the system had certain technical deficiencies which remain to be corrected to improve its reliability and to make it a workable production system.

It is recommended that work on at least the following elements of the system be continued:

1. Demonstrate a satisfactory method for joining faired surface areas
2. Impose restrictions on the signs of the curvatures at the terminations of stations and waterlines
3. Demonstrate a method for defining flat bottoms

These developments do not require any state-of-the-art breakthroughs, but are generally a matter of straightforward application of mathematics and computer programming. This work should be accomplished before the system is placed in full production usage. Efforts can then proceed on expanding the system capability for all cases and toward improving the economy of the system itself.

APPENDIX A

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APPENDIX A

PLANE CURVES

This Appendix contains three examples of curves faired with the linear programming method:

- Curve 1 Load Waterline - Forward
- Curve 2 Load Waterline - Aft
- Curve 3 Floor Frame Curve

A description of the procedure followed, a listing of the input data, a listing of the offsets of the faired curve, and a plot of the faired curve are presented in each case.

CURVE 1 LOAD WATERLINE - FORWARD

Project:

To fair the forward one-half of the load waterline of a 250' cargo ship to investigate the fairness quality of the faired line. In addition, it was desired to investigate the ability of the method to fit a straight section.

Data:

The preliminary offsets of Stations 1 through 8 and Station 10. Station 8 through 10 are all equal and within the parallel middle-body.

Procedure:

The second differences of the offsets were found to be consistent. The matrix was punched by hand using the lambda - primal formulation. In addition, the slope and curvature at Station 10 were required to be zero. The line was faired on the IBM-1620 in eight minutes. The offsets were solved from the equation using GOBACK 3 and were plotted as shown. In addition, the line was plotted at 1/4" = 1'0" for sight checking.

Results:

The greatest deviation (λ) was approximately 5/16". The line was found to satisfy both the mathematical and sight tests for fairness. The straight section was fit perfectly and the transition into the curve was fair.

Input Data - Curve 1 Load Waterline - Forward

LOAD WATERLINE-FWD PRELIM. OFFSETS

0.0	19.5
25.0	19.5
37.5	19.49
50.0	19.17
62.5	18.17
75.0	16.44
87.5	13.58
100.0	9.72
112.5	4.78
125.0	.08

$$A=4$$
11

17.00000000	19.50000000	.00000000	.00000000	041
18.00000000	19.50000000	.00000000	.00000000	042
19.00000000	19.50000000	.00000000	.00000000	043
20.00000000	19.50000000	.00000000	.00000000	044
21.00000000	19.50000000	.00000000	.00000000	045
22.00000000	19.50000000	.00000000	.00000000	046
23.00000000	19.50000000	.00000000	.00000000	047
24.00000000	19.50000000	.00000000	.00000000	048
25.00000000	19.50000000	.00000000	.00000000	049
26.00000000	19.49998700	-.00003972	-.00007944	050
27.00000000	19.49989500	-.00015888	-.00015888	051
28.00000000	19.49964300	-.00035748	-.00023832	052
29.00000000	19.49915300	-.00063552	-.00031776	053
30.00000000	19.49834500	-.00099300	-.00039720	054
31.00000000	19.49714100	-.00142993	-.00047664	055
32.00000000	19.49545900	-.00194629	-.00055608	056
33.00000000	19.49322200	-.00254210	-.00063552	057
34.00000000	19.49034800	-.00321734	-.00071496	058
35.00000000	19.48676000	-.00397203	-.00079440	059
36.00000000	19.48237800	-.00480616	-.00087384	060
37.00000000	19.47712200	-.00571972	-.00095328	061
37.50000000	19.47414100	-.00620630	-.00099300	062
38.00000000	19.47090500	-.00675537	-.00120328	063
39.00000000	19.46347900	-.00816894	-.00162384	064
40.00000000	19.45442700	-.01000306	-.00204439	065
41.00000000	19.44332000	-.01225773	-.00246495	066
42.00000000	19.42977200	-.01493296	-.00288550	067
43.00000000	19.41332600	-.01802875	-.00330606	068
44.00000000	19.39357400	-.02154509	-.00372661	069
45.00000000	19.37009600	-.02548198	-.00414717	070
46.00000000	19.34247000	-.02983943	-.00456772	071
47.00000000	19.31027700	-.03461744	-.00498828	072
48.00000000	19.27309500	-.03981600	-.00540883	073
49.00000000	19.23050400	-.04543512	-.00582939	074
50.00000000	19.18208500	-.05147479	-.00624995	075
51.00000000	19.12752700	-.05759552	-.0069149	076
52.00000000	19.06697900	-.06345778	-.0073303	077
53.00000000	19.00009700	-.06906158	-.00747457	078
54.00000000	18.92894100	-.07440692	-.00752161	079
55.00000000	18.85197000	-.07949382	-.0075765	080
56.00000000	18.77004000	-.08432225	-.00769920	081

57.00000000	18.68341100	-.08889222	-.00444074	082
58.00000000	18.59234200	-.09320373	-.00418228	083
59.00000000	18.49709100	-.09725679	-.00392382	084
60.00000000	18.39791500	-.10105139	-.00366536	085
61.00000000	18.29507400	-.10458752	-.00340690	086
62.00000000	18.18882500	-.10786520	-.00314845	087
63.00000000	18.13450500	-.10940712	-.00301922	088
64.00000000	18.07941500	-.11097605	-.00325649	089
65.00000000	17.96673100	-.11446982	-.00373105	090
66.00000000	17.85031700	-.11843815	-.00420560	091
67.00000000	17.72969700	-.12288103	-.00468015	092
68.00000000	17.60439600	-.12779846	-.00515470	093
69.00000000	17.47394300	-.13319044	-.00562925	094
70.00000000	17.33785700	-.13905698	-.00610381	095
71.00000000	17.19567000	-.14539806	-.00657836	096
72.00000000	17.04690400	-.15221370	-.00705291	097
73.00000000	16.89108300	-.15950389	-.00752746	098
74.00000000	16.72773700	-.16726864	-.00800201	099
75.00000000	16.55638900	-.17550793	-.00847656	100
76.00000000	16.37656300	-.18422178	-.00895112	101
77.00000000	16.18791500	-.19302543	-.00865016	102
78.00000000	15.99061100	-.20153412	-.00836121	103
79.00000000	15.78494500	-.20974786	-.00806626	104
80.00000000	15.57121400	-.21766662	-.00777131	105
81.00000000	15.34970900	-.22529051	-.00747635	106
82.00000000	15.12073000	-.23261938	-.00718140	107
83.00000000	14.88457000	-.23965331	-.00688645	108
84.00000000	14.64152200	-.24639227	-.00659149	109
85.00000000	14.39188200	-.25283629	-.00629654	110
86.00000000	14.13594700	-.25898534	-.00600159	111
87.00000000	13.87401000	-.26483945	-.00570663	112
88.00000000	13.60636600	-.27039862	-.00541168	113
89.00000000	13.47049600	-.27306761	-.00526420	114
90.00000000	13.33330000	-.27573968	-.00542412	115
91.00000000	13.05479500	-.28132374	-.00574396	116
92.00000000	12.77054500	-.28722761	-.00606380	117
93.00000000	12.48023100	-.29345130	-.00638364	118
94.00000000	12.18353600	-.29999487	-.00670347	119
95.00000000	11.88013700	-.30685834	-.00702331	120
	11.56971200	-.31404156	-.00734315	121
	11.25194600	-.32154458	-.00766299	122

96.00000000	10.92651700	-.32936754	-.00798282	123
97.00000000	10.59310600	-.33751029	-.00830266	124
98.00000000	10.25139000	-.34597288	-.00862250	125
99.00000000	9.90105200	-.35475526	-.00894234	126
100.00000000	9.54177240	-.36385754	-.00926217	127
101.00000000	9.17340440	-.37275733	-.00853744	128
102.00000000	8.79649960	-.38093242	-.00781270	129
103.00000000	8.41178000	-.38838277	-.00708797	130
104.00000000	8.01997510	-.39510832	-.00636323	131
105.00000000	7.62180510	-.40110924	-.00563850	132
106.00000000	7.21799720	-.40638536	-.00491376	133
107.00000000	6.80927680	-.41093676	-.00418903	134
108.00000000	6.39636610	-.41476344	-.00346429	135
109.00000000	5.97999050	-.41786536	-.00273956	136
110.00000000	5.56087620	-.42024252	-.00201482	137
111.00000000	5.13974760	-.42189504	-.00129009	138
112.00000000	4.71732780	-.42282272	-.00056535	139
112.50000000	4.50586150	-.42301484	-.00020298	140
113.00000000	4.29434220	-.42303792	-.00011040	141
114.00000000	3.87146320	-.42261416	-.00073720	142
115.00000000	3.44932180	-.42156360	-.00136400	143
116.00000000	3.02854580	-.41988612	-.00199079	144
117.00000000	2.60975820	-.41758196	-.00261759	145
118.00000000	2.19358940	-.41465096	-.00324439	146
119.00000000	1.78066500	-.41109320	-.00387118	147
120.00000000	1.37161200	-.40690860	-.00449798	148
121.00000000	.96705713	-.40209720	-.00512478	149
122.00000000	.56762635	-.39665909	-.00575157	150
123.00000000	.17394746	-.39059408	-.00637837	151
124.00000000	-.21335258	-.38390232	-.00700517	152
125.00000000	-.59364811	-.37658373	-.00763196	153

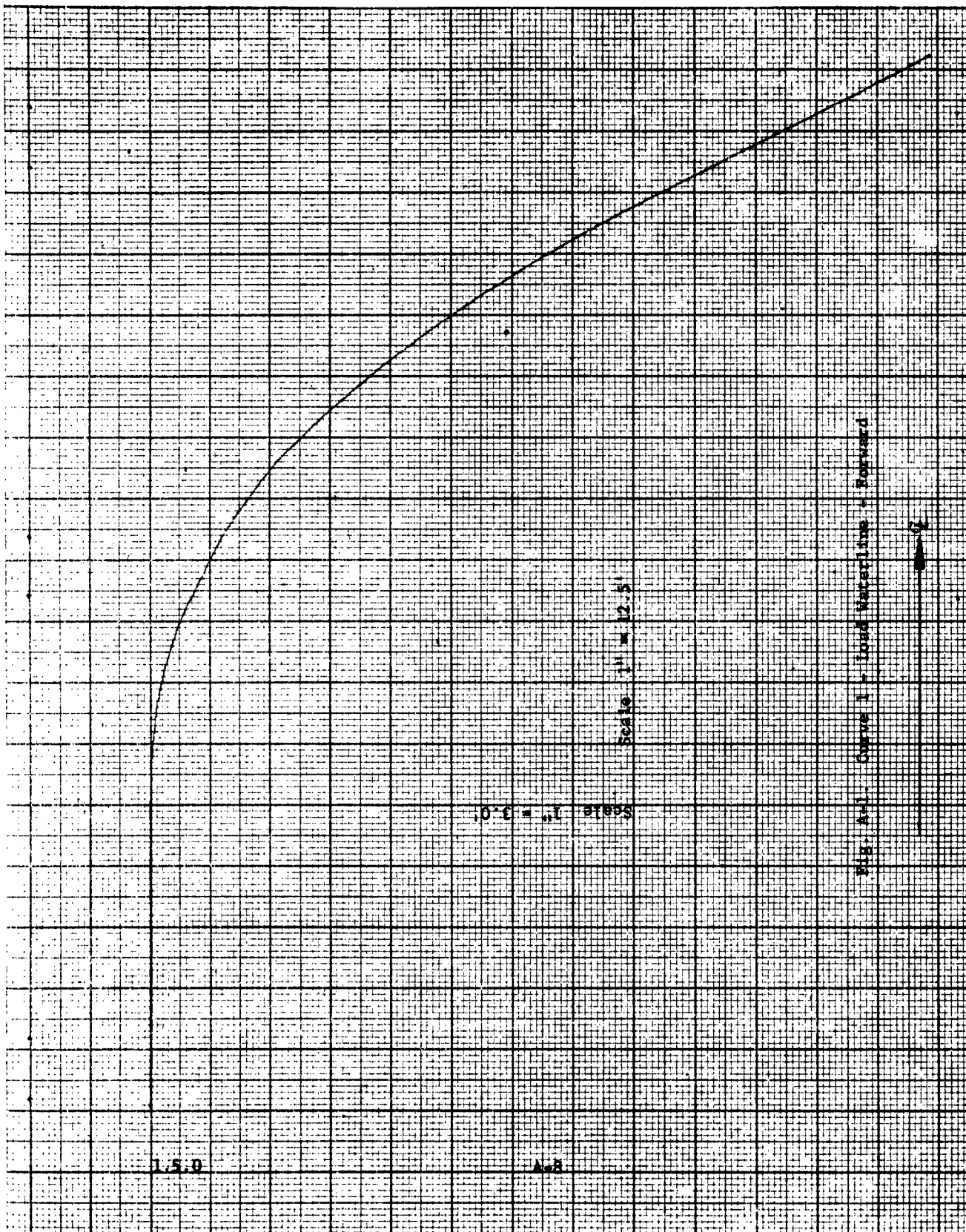


Fig. A-1. Curve 1 - Load Waterline - Forward



CURVE 2 LOAD WATERLINE - AFT

Project:

To fair the after one-half of the load waterline of a 250' cargo ship for investigating the fairness quality of the faired line and to determine the applicability of the fairing method.

Data:

The preliminary offsets of the eleven stations from Station 10 to Station 20, inclusive

Procedure:

The second differences of the offsets were found to be OK. The matrix was punched by hand using the lambda-primal formulation. The line was faired on the IBM-1620 computer in approximately ten minutes. Offsets were solved for using GOBACK 3 and were plotted as shown. Additionally, the line was plotted at a scale of $1/4" = 1'-0"$ to be checked for fairness.

Results:

On the larger scaled plot, the line was observed to contain a fairly flat section approximately fifty feet from amidships. The preliminary lines plan and offsets were reviewed and this confirmed that an intentional flat area exists in this portion of the hull. The curve was then found to meet the fairness criteria, both mathematically and by sight tests of a number of qualified individuals.

Input Data - Curve 2

LOAD WATERLINE-AFT PRELIM. OFFSETS

0.0	19.5
25.0	19.5
37.5	19.25
50.0	18.63
62.5	17.67
75.0	16.67
87.5	15.00
100.0	12.50
112.5	8.750
125.0	3.25

A-11

	LOAD	WATERLINE	AFT	FAIRED	OFFSETS	
	.00000000	1.00000000		19.50000000		154
	.08000000	.40000000		25.00000000		155
1	.00000000					156
2	.00000000					157
3	-.02698730					158
4	-.85554348					159
5	1.84188210					160
6	-1.46962800					161
7	.26551038					162
8	.00000000					163
9	-.46355964					164
10	.00000000					165
11	.00000000					166
1	25.00000000					167
2	37.50000000					168
3	50.00000000					169
4	62.50000000					170
5	75.00000000					171
6	87.50000000					172
7	100.00000000					173
8	112.50000000					174
9	125.00000000					175
		X	Y	FIRST DERIVAT.	SECOND DERIVAT.	176
	.00000000		19.50000000	.00000000	.00000000	177
	1.00000000		19.49999900	-.00000518	-.00001036	178
	2.00000000		19.49999870	-.00002072	-.00002072	179
	3.00000000		19.49999540	-.00004663	-.00003108	180
	4.00000000		19.49989000	-.00008290	-.00004145	181
	5.00000000		19.49978500	-.00012953	-.00005181	182
	6.00000000		19.49962700	-.00018653	-.00006217	183
	7.00000000		19.49940800	-.00025389	-.00007254	184
	8.00000000		19.49911600	-.00033161	-.00008290	185
	9.00000000		19.49874100	-.00041970	-.00009326	186
	10.00000000		19.49827300	-.00051815	-.00010363	187
	11.00000000		19.49770200	-.00062696	-.00011399	188
	12.00000000		19.49701600	-.00074614	-.00012435	189
	13.00000000		19.49620600	-.00087568	-.00013472	190
	14.00000000		19.49525100	-.00101558	-.00014508	191
	15.00000000		19.49417100	-.00116585	-.00015544	192
	16.00000000		19.49292600	-.00132647	-.00016580	193

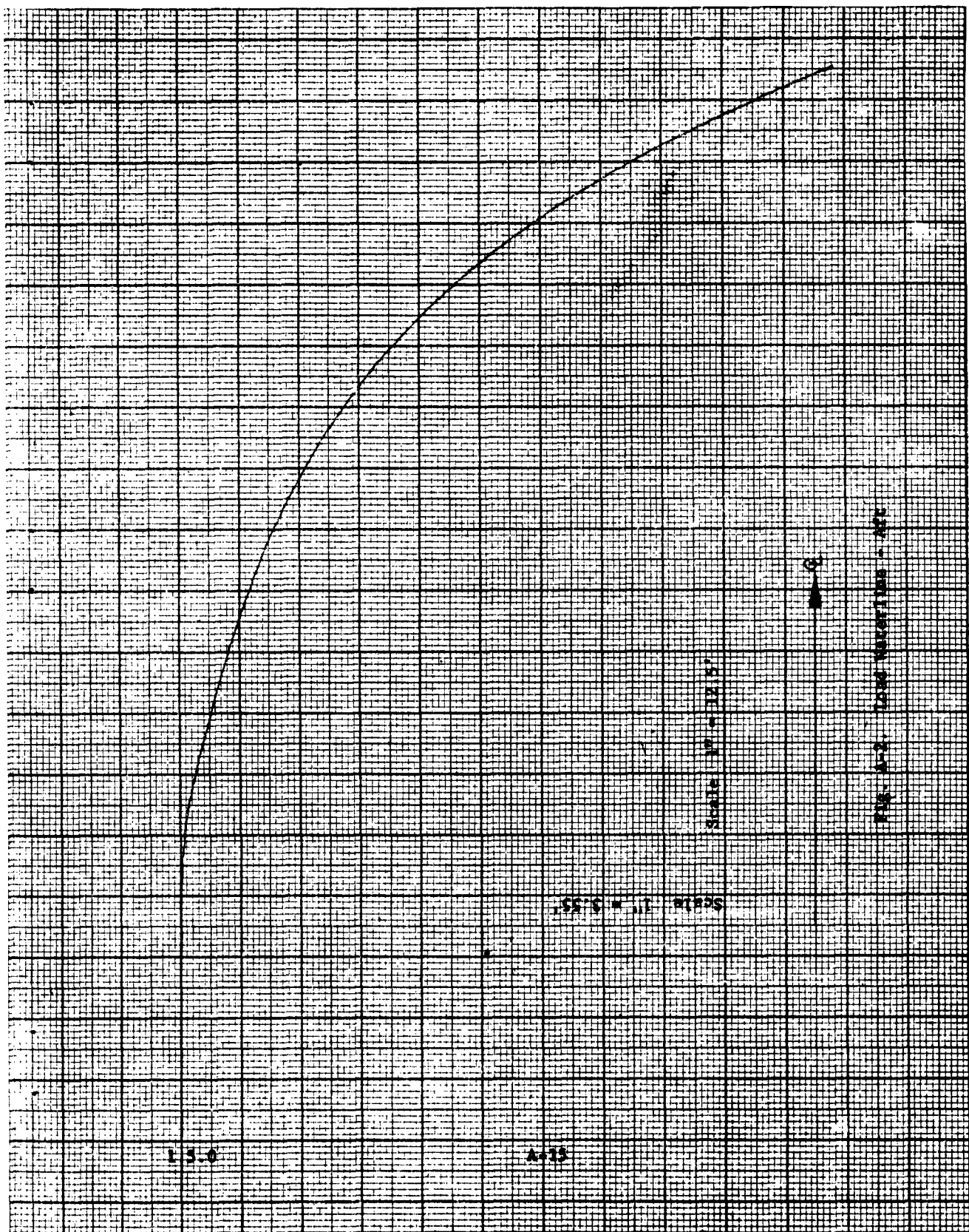
17.00000000	19.49151500	--.00149747	--.00017617	194
18.00000000	19.48992800	--.00167882	--.00018653	195
19.00000000	19.48815400	--.00187054	--.00019689	196
20.00000000	19.48618300	--.00207262	--.00020726	197
21.00000000	19.48400500	--.00228506	--.00021762	198
22.00000000	19.48160900	--.00250787	--.00022798	199
23.00000000	19.47898600	--.00274104	--.00023835	200
24.00000000	19.47612400	--.00298457	--.00024871	201
25.00000000	19.47301300	--.00323847	--.00025907	202
26.00000000	19.46958900	--.00366699	--.00059796	203
27.00000000	19.46556600	--.00443441	--.00093686	204
28.00000000	19.46060700	--.00554072	--.00127575	205
29.00000000	19.45437200	--.00698592	--.00161464	206
30.00000000	19.44652200	--.00877001	--.00195353	207
31.00000000	19.43671900	--.01089299	--.00229242	208
32.00000000	19.42462400	--.01335487	--.00263132	209
33.00000000	19.40989700	--.01615563	--.00297021	210
34.00000000	19.39219900	--.01929529	--.00330910	211
35.00000000	19.37119300	--.02277384	--.00364799	212
36.00000000	19.34653900	--.02659129	--.00398688	213
37.00000000	19.31789700	--.03074762	--.00432577	214
37.50000000	19.30197600	--.03295287	--.00449522	215
38.00000000	19.28494400	--.03515443	--.00431103	216
39.00000000	19.24769500	--.03928127	--.00394263	217
40.00000000	19.20650500	--.04303972	--.00357424	218
41.00000000	19.16174000	--.04642977	--.00320585	219
42.00000000	19.11376800	--.04945143	--.00283746	220
43.00000000	19.06296000	--.05210470	--.00246907	221
44.00000000	19.00968100	--.05438958	--.00210068	222
45.00000000	18.95430300	--.05630607	--.00173229	223
46.00000000	18.89719200	--.05785417	--.00136390	224
47.00000000	18.83871800	--.05903388	--.00099551	225
48.00000000	18.77924700	--.05984519	--.00062712	226
49.00000000	18.71915000	--.06028812	--.00025873	227
50.00000000	18.65879400	--.06036265	--.00010966	228
51.00000000	18.59845300	--.06035096	--.00008628	229
52.00000000	18.53802700	--.06053522	--.00028223	230
53.00000000	18.47731800	--.06091543	--.00047817	231
54.00000000	18.41613100	--.06149158	--.00067412	232
55.00000000	18.35426900	--.06226368	--.00087007	233
56.00000000	18.29153800	--.06323172	--.00106601	234

57.00000000	18.22774100	--.06439571	--.00126196	235
58.00000000	18.16268200	--.06575564	--.00145790	236
59.00000000	18.09616500	--.06731152	--.00165385	237
60.00000000	18.02799300	--.06906336	--.00184980	238
61.00000000	17.95797200	--.07101113	--.00204574	239
62.00000000	17.88590400	--.07315485	--.00224169	240
62.50000000	17.84904400	--.07430019	--.00233966	241
63.00000000	17.81160000	--.07548178	--.00238666	242
64.00000000	17.73490800	--.07791543	--.00248065	243
65.00000000	17.65573700	--.08044308	--.00257464	244
66.00000000	17.57399000	--.08306472	--.00266863	245
67.00000000	17.48957500	--.08578035	--.00276262	246
68.00000000	17.40239900	--.08858997	--.00285661	247
69.00000000	17.31236400	--.09149357	--.00295060	248
70.00000000	17.21938000	--.09449118	--.00304459	249
71.00000000	17.12335000	--.09758277	--.00313858	250
72.00000000	17.02418300	--.10076830	--.00323257	251
73.00000000	16.92178300	--.10404789	--.00332656	252
74.00000000	16.81605600	--.10742146	--.00342055	253
75.00000000	16.70690800	--.11088905	--.00351454	254
76.00000000	16.59424700	--.11445054	--.00360853	255
77.00000000	16.47797600	--.11810609	--.00370252	256
78.00000000	16.35800300	--.12185562	--.00379651	257
79.00000000	16.23423300	--.12569913	--.00389050	258
80.00000000	16.10657300	--.12963659	--.00398449	259
81.00000000	15.97492900	--.13366810	--.00407848	260
82.00000000	15.83920600	--.13779356	--.00417247	261
83.00000000	15.69930900	--.14201304	--.00426646	262
84.00000000	15.55514800	--.14632653	--.00436045	263
85.00000000	15.40662600	--.15073397	--.00445444	264
86.00000000	15.25364900	--.15523544	--.00454843	265
87.00000000	15.09612300	--.15983084	--.00464242	266
87.50000000	15.01562600	--.16216383	--.00468942	267
88.00000000	14.93395300	--.16454256	--.00482541	268
89.00000000	14.76695100	--.16950392	--.00509741	269
90.00000000	14.59485400	--.17473740	--.00536941	270
91.00000000	14.41738600	--.18024273	--.00564141	271
92.00000000	14.23427800	--.18602019	--.00591340	272
93.00000000	14.04525500	--.19206959	--.00618540	273
94.00000000	13.85004700	--.19839100	--.00645740	274
95.00000000	13.64838300	--.20498438	--.00672940	275

1.6.0

96.00000000	13.43998900	--.21184980	--.00700139	276
97.00000000	13.22459200	--.21898720	--.00727339	277
98.00000000	13.00192300	--.22639657	--.00754539	278
99.00000000	12.77170700	--.23407803	--.00781738	279
100.00000000	12.53367600	--.24203142	--.00808938	280
101.00000000	12.28755600	--.25025678	--.00836138	281
102.00000000	12.03307100	--.25875420	--.00863338	282
103.00000000	11.76995400	--.26752354	--.00890537	283
104.00000000	11.49793500	--.27656494	--.00917737	284
105.00000000	11.21673400	--.28587826	--.00944937	285
106.00000000	10.92608800	--.29546364	--.00972136	286
107.00000000	10.62571700	--.30532102	--.00999336	287
108.00000000	10.31535400	--.31545038	--.01026536	288
109.00000000	9.99472500	--.32585180	--.01053735	289
110.00000000	9.66356000	--.33652515	--.01080935	290
111.00000000	9.32158400	--.34747055	--.01108135	291
112.00000000	8.96852700	--.35868788	--.01135335	292
113.00000000	8.78775840	--.36439851	--.01148935	293
114.00000000	8.60411770	--.37017721	--.01162534	294
115.00000000	8.22808400	--.38193855	--.01189734	295
116.00000000	7.84014980	--.39397190	--.01216934	296
117.00000000	7.44004810	--.40627724	--.01244134	297
118.00000000	7.02750480	--.41885456	--.01271333	298
119.00000000	6.60224800	--.43170388	--.01298533	299
120.00000000	6.16400550	--.44482524	--.01325733	300
121.00000000	5.71250630	--.45821864	--.01352932	301
122.00000000	5.24747830	--.47188396	--.01380132	302
123.00000000	4.76864760	--.48582120	--.01407332	303
124.00000000	4.27574490	--.50003056	--.01434532	304
125.00000000	3.76849640	--.51451192	--.01461731	305
	3.24662990	--.52926520	--.01488931	306

A-14



CURVE 3 FLOOR FRAME CURVE

Project:

To fair a curve taken from a transverse section of a ship hull to determine the applicability of the fairing method.

Data:

The data was taken from previously faired offsets of a floor frame of the DLG-26. It contained seven offsets.

Procedure:

The matrix was punched by SMOG 4 in the sum of the deviations formulation. The curve was faired on the IBM-1620 and required two minutes to fair. The offsets were solved for using GOBACK 3. In addition, ten offsets from the curve were chosen at random and sent to the loft to be plotted at a scale of 1" - 1'-0" vertically.

Results:

The faired curve passed exactly through every data point. The offsets which were sent to the loft were fit with a batten and were found to be fair without changes.

Curve 3

FLOOR FRAME CURVE PRFLIM. OFFSETS

1.0	6.44
2.0	8.13
3.0	10.32
4.0	13.14
5.0	6.68
6.0	21.08
7.0	26.36

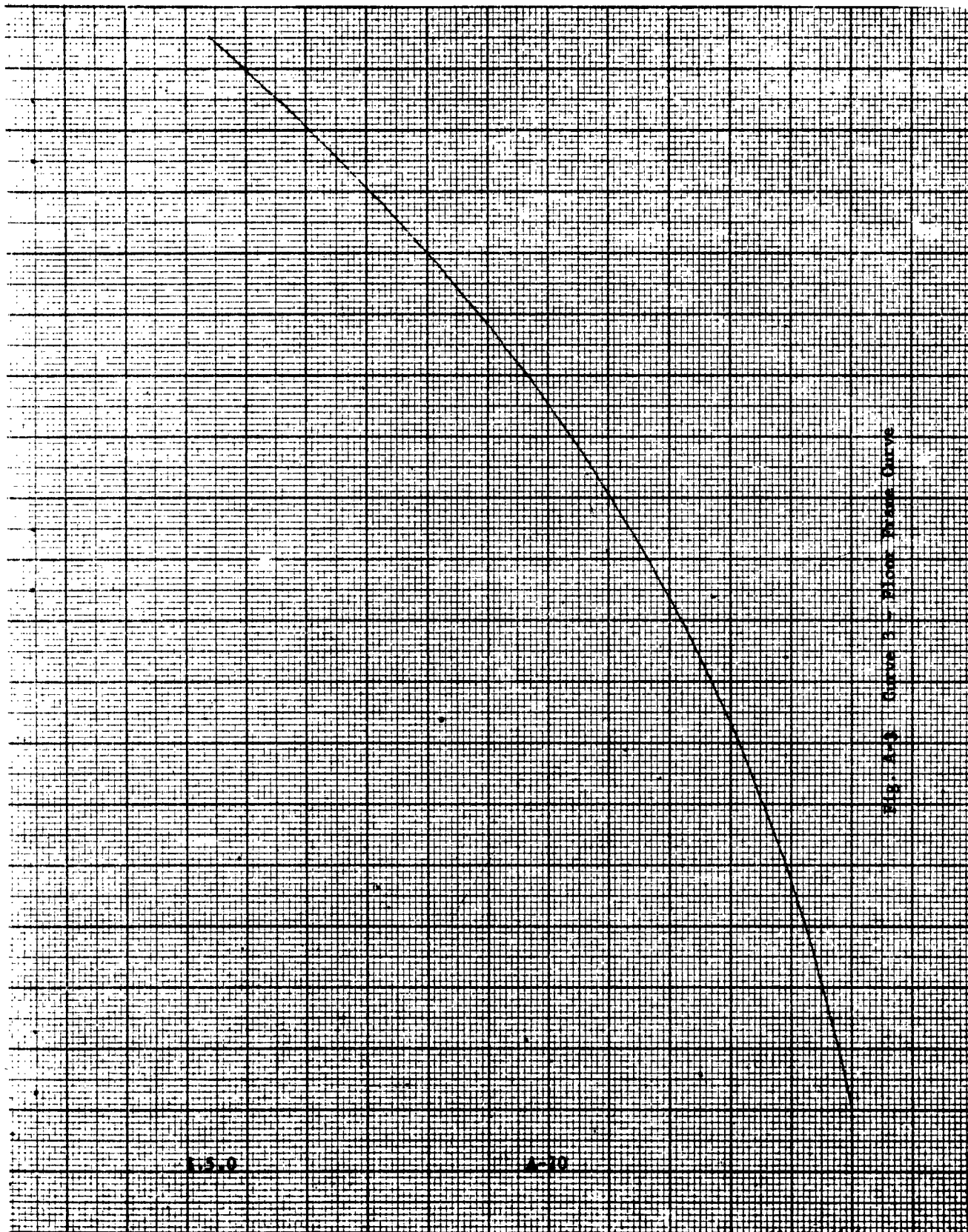
1.5.0

DLC 26 FLOOR FRAME CURVE FAIRED OFFSETS									
	.00000000	.25000000	5.19000000						
2	.00000000	.50000000	1.00000000	9	7	0			
1	1.15870760								307
2	.00000000								308
3	.09129244								309
4	-.10775472								310
5	.05101856								311
6	-.02631842								312
7	.01940595								313
8	-.02494013								314
9	.00000000								315
1	1.00000000								316
2	2.00000000								317
3	3.00000000								318
4	4.00000000								319
5	5.00000000								320
6	6.00000000								321
7	7.00000000								322
									323
									324
									325
									326
									327
									328
									329
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									344
									345
									346

		FIRST DERIVAT.		SECOND DERIVAT.	
	Y				
	5.19000000	1.15870760	.00000000		
	5.48110330	1.17582490	.13693867		
	5.78076530	1.22717690	.27387734		
	6.09754470	1.31276360	.41081601		
	6.44000000	1.43258490	.54775468		
	6.81500640	1.56643690	.52304127		
	7.22270410	1.69411560	.49836786		
	7.66154970	1.81562090	.47367445		
	8.13000000	1.93095290	.44898110		
	8.62730880	2.04967730	.50081544		
	9.15591870	2.18136060	.55264999		
	9.71906940	2.32600240	.60448433		
	10.31999900	2.48360270	.65631877		
	10.96153900	2.64922700	.66867557		
	11.64487100	2.81794050	.68103238		
	12.37076600	2.98974310	.69338918		
	13.13999900	3.16463530	.70574588		
	13.95364400	3.34625480	.74721171		
	14.81399100	3.53824070	.78867746		
	15.72362900	3.74059370	.83014311		
	16.68515100	3.95331240	.87160885		

1.5.0

5.25000000	17.70076000	4.17172160	.87566440	347
5.50000000	18.77109700	4.39114510	.87971994	348
5.75000000	19.89641500	4.61158220	.88377547	349
6.00000000	21.07697100	4.83303170	.88783120	350
6.25000000	22.31301500	5.05549740	.89188660	351
6.50000000	23.60480500	5.27897650	.89594210	352
6.75000000	24.95259000	5.50346760	.89999770	353
7.00000000	26.35662200	5.72897420	.90405330	354



APPENDIX B

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Appendix B

SURFACES

Contained in this Appendix are several examples of surfaces faired as tests for the mathematical lofting system. Included are the preliminary data, final faired results, and a plot of the surfaces.

DOUBLE SPLINED 8 x 10 SURFACE

Project:

To fair a surface of DLG-26 containing eight waterlines and ten stations using the double spline concept to determine the applicability of the technique.

Data:

The data used were preliminary offsets taken from DLG-26 Drawing No. 2068017 on Stations 2 through 12 at Waterlines 4 through 32, at four-foot intervals.

Procedure:

The data was smoothed and then used with SMOG-3 to punch the matrix in the sum of the deviations-primal formulation, using the double spline in both waterline and station directions. The surface was then faired on the IBM-7090 using LP-90. Results were solved for using GOBACK 1.

Results:

The deviation between the surface and the offsets were reasonable in all cases and generally very small. The surface meets all the requirements for fairness, including sight tests.

DLG 26 8 x 10 PRELIMINARY OFFSETS - SURFACE

8	10	.001000
4.0000		
.0000	3.593749	
25.5000	7.833333	
51.0000	5.666666	
76.5000	10.031250	
102.0000	12.354166	
127.5000	14.645833	
153.0000	16.593749	
178.5000	18.020833	
204.0000	18.677082	
229.5000	18.437499	
8.0000		
.0000	4.729166	
25.5000	7.500000	
51.0000	10.322916	
76.5000	13.302083	
102.0000	16.250000	
127.5000	18.874999	
153.0000	21.000000	
178.5000	22.562500	
204.0000	23.458332	
229.5000	23.791666	
12.0000		
.0000	5.333333	
25.5000	8.427083	
51.0000	11.781250	
76.5000	15.166666	
102.0000	18.343749	
127.5000	21.072916	
153.0000	23.239582	
178.5000	24.770833	
204.0000	25.760416	
229.5000	26.156249	
16.0000		
.0000	5.812500	
25.5000	9.250000	
51.0000	12.916666	
76.5000	16.354166	
102.0000	19.666666	
127.5000	22.291666	
153.0000	24.364583	
178.5000	25.770833	
204.0000	26.708332	
229.5000	27.187499	

20.0000	
.0000	6.333333
25.5000	10.124999
51.0000	14.114583
76.5000	17.697916
102.0000	20.708332
127.5000	23.104166
153.0000	24.885416
178.5000	26.114583
204.0000	26.895833
229.5000	27.291666
24.0000	
.0000	7.166666
25.5000	11.374999
51.0000	15.468749
76.5000	18.937499
102.0000	21.635416
127.5000	23.718749
153.0000	25.208332
178.5000	26.208332
204.0000	26.895833
229.5000	27.239582
28.0000	
.0000	8.583333
25.5000	13.093749
51.0000	17.000000
76.5000	20.229166
102.0000	22.520833
127.5000	24.229166
153.0000	25.416666
178.5000	26.229166
204.0000	26.843749
229.5000	27.187499
32.0000	
.0000	10.750000
25.5000	15.260416
51.0000	18.916666
76.5000	21.624999
102.0000	23.395833
127.5000	24.583333
153.0000	25.510416
178.5000	26.208332
204.0000	26.739582
229.5000	27.093749

1.5.0

STATION	OFFSETS	5 X 6	DOUBLE INTERVAL	FIRST DER.	SECOND DER.
FR 0.00	5.00000000		3.76376360	.17002366	0.00000000
FR 0.00	6.00000000		3.93378730	.17002366	0.00000000
FR 0.00	7.00000000		4.10381090	.17002366	0.00000000
FR 0.00	8.00000000		4.27383460	.17002366	0.00000000
FR 0.00	9.00000000		4.44385830	.17002366	0.00000000
FR 0.00	10.00000000		4.61388190	.17002366	0.00000000
FR 0.00	11.00000000		4.78390560	.17002366	0.00000000
FR 0.00	12.00000000		4.95392930	.17002366	0.00000000
FR 0.00	13.00000000		5.12399040	.17013627	0.00022524
FR 0.00	14.00000000		5.29427690	.17047415	0.00045049
FR 0.00	15.00000000		5.46501380	.17103727	0.00067574
FR 0.00	16.00000000		5.63642650	.17182565	0.00090099
FR 0.00	17.00000000		5.80874030	.17283927	0.00112624
FR 0.00	18.00000000		5.98218010	.17407815	0.00135149
FR 0.00	19.00000000		6.15697160	.17554227	0.00157674
FR 0.00	20.00000000		6.33333990	.17723165	0.00180199
FR 0.00	21.00000000		6.51143750	.17892865	0.00159199
FR 0.00	22.00000000		6.69112720	.18041565	0.00138199
FR 0.00	23.00000000		6.87219880	.18169263	0.00117198
FR 0.00	24.00000000		7.05444240	.18275962	0.00096198
FR 0.00	25.00000000		7.23764810	.18361660	0.00075197
FR 0.00	26.00000000		7.42160560	.18426357	0.00054197
FR 0.00	27.00000000		7.60610520	.18470055	0.00033197
FR 0.00	28.00000000		7.79093680	.18492751	0.00012196
FR 0.00	29.00000000		7.97592010	.18503423	0.00009147
FR 0.00	30.00000000		8.16099500	.18511046	0.00006098
FR 0.00	31.00000000		8.34613090	.18515618	0.00003049
FR 0.00	32.00000000		8.53129730	.18517145	0.00000000
PEN UP	6000.00000000				
GO TO	4.00000000		8.53129730		

IDENT. Z
 FR 25.50 4.00000000
 PEN DOWN 5000.00000000
 FIRST DER. 5.66663990
 SECOND DER. -.11052347

FR 25.50	5.00000000	6.25710830	.53969607	-.09705550
FR 25.50	6.00000000	6.75052130	.44937455	-.08358754
FR 25.50	7.00000000	7.16034680	.37252098	-.07011957
FR 25.50	8.00000000	7.50005270	.30913540	-.05665161
FR 25.50	9.00000000	7.78310690	.25921776	-.04318364
FR 25.50	10.00000000	8.02297750	.22276810	-.02971568
FR 25.50	11.00000000	8.23313160	.19978640	-.01624771
FR 25.50	12.00000000	8.42703940	.19027267	-.00277975
FR 25.50	13.00000000	8.61644000	.18904372	.00032185
FR 25.50	14.00000000	8.80616110	.19091638	.00342345
FR 25.50	15.00000000	8.99430600	.19589063	.00652506
FR 25.50	16.00000000	9.19897560	.20396651	.00962666
FR 25.50	17.00000000	9.40827320	.21514393	.01272826
FR 25.50	18.00000000	9.63029700	.22942298	.01582987
FR 25.50	19.00000000	9.86815300	.24680363	.01893147
FR 25.50	20.00000000	10.12493900	.26728591	.02203307
FR 25.50	21.00000000	10.40331200	.28953440	.02246378
FR 25.50	22.00000000	10.70415100	.31221348	.02289449
FR 25.50	23.00000000	11.02788200	.33532332	.02332520
FR 25.50	24.00000000	11.37494100	.35886390	.02375591
FR 25.50	25.00000000	11.74575500	.38283531	.02418661
FR 25.50	26.00000000	12.14075500	.40723726	.02461733
FR 25.50	27.00000000	12.56037400	.43206993	.02504804
FR 25.50	28.00000000	13.00503900	.45733310	.02547874
FR 25.50	29.00000000	13.47858500	.49322937	.04631399
FR 25.50	30.00000000	13.99844300	.54996105	.06714923
FR 25.50	31.00000000	14.58545200	.62752801	.08798449
FR 25.50	32.00000000	15.26044500	.72593011	.10881974
PEN UP	6000.00000000			
GO TO	4.00000000	15.26044500		

7.78364360
6.73399720
-3.88521860
1.14881730
-.82813290
-.41163256
1.84982390

IDENT.

2

FR 51.00	4.00000000	7.78364360	FIRST DER.	SECOND DER.
PEN DOWN	5000.00000000		.84174965	-.12141308
FR 51.00	5.00000000	8.56693040	.72706792	-.10795037

FR	51.00	6.00000000	9.24226700	.62584888	-.09448767
FR	51.00	7.00000000	9.82311610	.53809256	-.08102497
FR	51.00	8.00000000	10.32294000	.46379893	-.06756227
FR	51.00	9.00000000	10.75520000	.40296802	-.05409956
FR	51.00	10.00000000	11.13336300	.35559980	-.04063686
FR	51.00	11.00000000	11.47088800	.32169430	-.02717416
FR	51.00	12.00000000	11.78123900	.30125148	-.01371145
FR	51.00	13.00000000	12.07626200	.28941902	-.00995344
FR	51.00	14.00000000	12.36133000	.28134460	-.00619541
FR	51.00	15.00000000	12.64020300	.27702818	-.00243739
FR	51.00	16.00000000	12.91663900	.27646988	.00132061
FR	51.00	17.00000000	13.19439500	.27966946	.00507863
FR	51.00	18.00000000	13.47723100	.28662697	.00883665
FR	51.00	19.00000000	13.76890200	.29734278	.01259467
FR	51.00	20.00000000	14.07316900	.31181641	.01635269
FR	51.00	21.00000000	14.39298500	.32763621	.01528690
FR	51.00	22.00000000	14.72808600	.34239025	.01422110
FR	51.00	23.00000000	15.07741000	.35607842	.01315530
FR	51.00	24.00000000	15.43988800	.36870082	.01208950
FR	51.00	25.00000000	15.81445600	.38025752	.01102371
FR	51.00	26.00000000	16.20004800	.39074826	.00995791
FR	51.00	27.00000000	16.59559800	.40017332	.00889211
FR	51.00	28.00000000	17.00004100	.40853242	.00782632
FR	51.00	29.00000000	17.41591900	.42666477	.02843814
FR	51.00	30.00000000	17.86023900	.46540867	.04904996
FR	51.00	31.00000000	18.35361000	.52476465	.06966179
FR	51.00	32.00000000	18.91663900	.60473216	.09027361
PEN UP	6000.00000000				
GO TO	4.00000000		18.91663900		

			Y	FIRST DER.	SECOND DER.
IDENT.					
FR	76.50	4.00000000	10.03124000	1.08973850	-.16012654
PEN DOWN	5000.00000000				
FR	76.50	5.00000000	11.04382400	.93834048	-.14266964
FR	76.50	6.00000000	11.91373900	.80439930	-.12521273

FR 76.50	7.000000000	12.65844200	.68791502	-.10775582
FR 76.50	8.000000000	13.29538900	.58888767	-.09029890
FR 76.50	9.000000000	13.84203600	.50731722	-.07284200
FR 76.50	10.000000000	14.31584100	.44320368	-.05538509
FR 76.50	11.000000000	14.73426300	.39654706	-.03792817
FR 76.50	12.000000000	15.11475500	.36734727	-.02047126
FR 76.50	13.000000000	15.47236900	.34838076	-.01746185
FR 76.50	14.000000000	15.81252000	.33242367	-.01445242
FR 76.50	15.000000000	16.13821900	.31947587	-.01144301
FR 76.50	16.000000000	16.45247400	.30953753	-.00843360
FR 76.50	17.000000000	16.75829600	.30260867	-.00542419
FR 76.50	18.000000000	17.05869600	.29868920	-.00241477
FR 76.50	19.000000000	17.35667800	.29777910	.00059463
FR 76.50	20.000000000	17.65525700	.29987837	.00360404
FR 76.50	21.000000000	17.95686200	.30325721	.00315356
FR 76.50	22.000000000	18.26162000	.30618551	.00270306
FR 76.50	23.000000000	18.56908300	.30866316	.00225257
FR 76.50	24.000000000	18.87879900	.31069087	.00180209
FR 76.50	25.000000000	19.19031600	.31226767	.00135160
FR 76.50	26.000000000	19.50318200	.31339393	.00090110
FR 76.50	27.000000000	19.81695100	.31406978	.00045060
FR 76.50	28.000000000	20.13117100	.31429498	.00000012
FR 76.50	29.000000000	20.44738000	.32003001	.01146986
FR 76.50	30.000000000	20.77505300	.33723473	.02293958
FR 76.50	31.000000000	21.12567100	.36590940	.03440932
FR 76.50	32.000000000	21.51069700	.40605363	.04587905
PEN UP	6000.00000000			
GO TO	4.000000000	21.51069700		

IDENT.	2		FIRST DER.	SECOND DER.
FR 102.00	4.000000000	12.35413900	1.32635160	-.20566781
PEN DOWN	5000.00000000			
FR 102.00	5.000000000	13.58134100	1.13173860	-.18355818
FR 102.00	6.000000000	14.62498600	.95923525	-.16144856
FR 102.00	7.000000000	15.50718100	.80884156	-.13933893

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FR 102.00	8.00000000	16.25003900	.68055737	-.11722931
FR 102.00	9.00000000	16.87566700	.57438293	-.09511968
FR 102.00	10.00000000	17.40617400	.49031800	-.07301006
FR 102.00	11.00000000	17.86367200	.42836281	-.05090043
FR 102.00	12.00000000	18.27027000	.38851712	-.02879081
FR 102.00	13.00000000	18.64484900	.36109847	-.02604662
FR 102.00	14.00000000	18.99338200	.33642387	-.02330244
FR 102.00	15.00000000	19.31861100	.31449351	-.02055826
FR 102.00	16.00000000	19.62328400	.29530733	-.01781408
FR 102.00	17.00000000	19.91014200	.27886535	-.01506990
FR 102.00	18.00000000	20.18193000	.26516753	-.01232572
FR 102.00	19.00000000	20.44139200	.25421390	-.00958153
FR 102.00	20.00000000	20.69127200	.24600445	-.00683735
FR 102.00	21.00000000	20.93400500	.23960970	-.00595215
FR 102.00	22.00000000	21.17078800	.23410016	-.00506694
FR 102.00	23.00000000	21.40250100	.22947585	-.00418173
FR 102.00	24.00000000	21.63003300	.22573667	-.00329654
FR 102.00	25.00000000	21.85426900	.22288276	-.00241133
FR 102.00	26.00000000	22.07609400	.22091400	-.00152612
FR 102.00	27.00000000	22.29639200	.21983051	-.00064093
FR 102.00	28.00000000	22.51605000	.21963216	.00024427
FR 102.00	29.00000000	22.73579500	.21984588	.00018330
FR 102.00	30.00000000	22.95572300	.21999867	.00012231
FR 102.00	31.00000000	23.17577300	.22009057	.00006133
FR 102.00	32.00000000	23.39588200	.22012142	.00000034
PEN UP	0000.00000000			
GO TO	4.00000000	23.39588200		

IDENT.	Z	Y	FIRST DER.	SECOND DER.
FR 127.50	4.00000000	14.62796200	1.43579410	-.21535337
PEN DOWN	5000.00000000			
FR 127.50	5.00000000	15.95962100	1.23106410	-.19410664
FR 127.50	6.00000000	17.09717200	1.04758080	-.17285989
FR 127.50	7.00000000	18.06186400	.88534433	-.15161315
FR 127.50	8.00000000	18.87494200	.74435456	-.13036640

13.9

FR 127.50	9.00000000	19.55765500	.62461152	-.10911967
FR 127.50	10.00000000	20.13124800	.52611523	-.08787292
FR 127.50	11.00000000	20.61696800	.44886570	-.06662618
FR 127.50	12.00000000	21.03606200	.39286290	-.04537943
FR 127.50	13.00000000	21.40697200	.34969436	-.04095762
FR 127.50	14.00000000	21.73692400	.31094766	-.03653580
FR 127.50	15.00000000	22.03034100	.27662271	-.03211399
FR 127.50	16.00000000	22.29164400	.24671960	-.02769217
FR 127.50	17.00000000	22.52525600	.22123843	-.02327036
FR 127.50	18.00000000	22.73559500	.20017896	-.01884853
FR 127.50	19.00000000	22.92708600	.18354120	-.01442672
FR 127.50	20.00000000	23.10415200	.17132550	-.01000490
FR 127.50	21.00000000	23.27062100	.16175785	-.00913042
FR 127.50	22.00000000	23.42796100	.15306443	-.00825592
FR 127.50	23.00000000	23.57704100	.14524588	-.00738144
FR 127.50	24.00000000	23.71874300	.13830173	-.00650696
FR 127.50	25.00000000	23.85393600	.13223212	-.00563248
FR 127.50	26.00000000	23.98350000	.12703705	-.00475798
FR 127.50	27.00000000	24.10830000	.12271590	-.00388350
FR 127.50	28.00000000	24.22922300	.11926980	-.00300902
FR 127.50	29.00000000	24.34544600	.11163701	-.01225673
FR 127.50	30.00000000	24.44941700	.09475657	-.02150443
FR 127.50	31.00000000	24.53187800	.06862797	-.03075215
FR 127.50	32.00000000	24.58358600	.03325198	-.03999987
PEN UP	6000.00000000			
GO TO	4.00000000	24.58358600		

16.59374100			
11.75612400			
-6.66254610			
1.55097370			
-.97815060			
-.53958440			
-1.13466530			
IDENT.			
FR 153.00	4.00000000	16.59374100	1.46951550
PEN DOWN	5000.00000000		
FR 153.00	5.00000000	17.96218300	1.27039860
FR 153.00	6.00000000	19.14059600	1.08945730
FR 153.00	7.00000000	20.14715600	.92669150
FR 153.00	8.00000000	21.00003800	.78210102
FR 153.00	9.00000000	21.71741600	.65568615

SECOND DER.
- .20820456

FIRST DER.
1.46951550

Y
16.59374100

Z
4.00000000

1.0.0

FR 153.00	10.00000000	22.31746900	.54744663	-.09915173
FR 153.00	11.00000000	22.81836900	.45738270	-.08097626
FR 153.00	12.00000000	23.23829200	.38549413	-.06280078
FR 153.00	13.00000000	23.59350500	.32604980	-.05608801
FR 153.00	14.00000000	23.89263000	.27331811	-.04937524
FR 153.00	15.00000000	24.14237800	.22729933	-.04266246
FR 153.00	16.00000000	24.34946700	.18799313	-.03594970
FR 153.00	17.00000000	24.52060300	.15539985	-.02923693
FR 153.00	18.00000000	24.66250400	.12951923	-.02252416
FR 153.00	19.00000000	24.78188100	.11035155	-.01581138
FR 153.00	20.00000000	24.88544400	.09789652	-.00909861
FR 153.00	21.00000000	24.97885800	.08899268	-.00870910
FR 153.00	22.00000000	25.06356000	.08047825	-.00831959
FR 153.00	23.00000000	25.13994500	.07235336	-.00793006
FR 153.00	24.00000000	25.20839700	.06461802	-.00754055
FR 153.00	25.00000000	25.26930900	.05727223	-.00715103
FR 153.00	26.00000000	25.32307400	.05031617	-.00676151
FR 153.00	27.00000000	25.37007000	.04374938	-.00637200
FR 153.00	28.00000000	25.41070000	.03757210	-.00598249
FR 153.00	29.00000000	25.44313000	.02513600	-.01888983
FR 153.00	30.00000000	25.45667300	-.00020769	-.03179717
FR 153.00	31.00000000	25.43841300	-.03845851	-.04470451
FR 153.00	32.00000000	25.37545100	-.08961683	-.05761186
PEN UP	6000.00000000			
GO TO	4.00000000	25.37545100		

17.98964900
12.08811800
-6.79092030
1.48398990
-.79268605
-.63973679
-.87731016

IDENT.	Z	Y	FIRST DER.	SECOND DER.
FR 178.50	4.00000000	17.98964900	1.51101470	-.21221625
PEN DOWN	5000.00000000			
FR 178.50	5.00000000	19.39745300	1.30749370	-.19482575
FR 178.50	6.00000000	20.61043300	1.12136320	-.17743525
FR 178.50	7.00000000	21.64597700	.95262327	-.16004473
FR 178.50	8.00000000	22.52147600	.80127380	-.14265423
FR 178.50	9.00000000	23.25432100	.66731482	-.12526371
FR 178.50	10.00000000	23.86190300	.55074636	-.10787321

1.50

FR 178.50	11.00000000	24.36161100	.45156840	--.09048271
FR 178.50	12.00000000	24.77083600	.36978096	--.07309220
FR 178.50	13.00000000	25.10542100	.30073937	--.06499099
FR 178.50	14.00000000	25.37501600	.23979900	--.05688976
FR 178.50	15.00000000	25.58772000	.18695983	--.04878855
FR 178.50	16.00000000	25.75163600	.14222181	--.04068732
FR 178.50	17.00000000	25.87486400	.10558513	--.03258611
FR 178.50	18.00000000	25.96550700	.07704967	--.02448490
FR 178.50	19.00000000	26.03166400	.05661528	--.01638368
FR 178.50	20.00000000	26.08143800	.04428223	--.00828247
FR 178.50	21.00000000	26.12168000	.03630195	--.00767816
FR 178.50	22.00000000	26.15424500	.02892570	--.00707386
FR 178.50	23.00000000	26.17973200	.02215425	--.00646955
FR 178.50	24.00000000	26.19875400	.01598684	--.00586526
FR 178.50	25.00000000	26.21190800	.01042361	--.00526096
FR 178.50	26.00000000	26.21980400	.00546480	--.00465664
FR 178.50	27.00000000	26.22303900	.00111015	--.00405236
FR 178.50	28.00000000	26.22222600	--.00263966	--.00344804
FR 178.50	29.00000000	26.21624900	--.01092617	--.01312473
FR 178.50	30.00000000	26.19714900	--.02888933	--.02280139
FR 178.50	31.00000000	26.15524300	--.05652913	--.03247808
FR 178.50	32.00000000	26.08086200	--.09384571	--.04215475
PEN UP	6000.00000000			
GO TO	4.00000000	26.08086200		
	18.67703900			
	12.83775500			
	-7.34626030			
	1.59190880			
	--.81413440			
	--.69582357			
	--.41680171			

IDENT.	Z	Y	FIRST DER.	SECOND DER.
FR 204.00	4.00000000	18.67703900	1.60471930	--.22957062
PEN DOWN	5000.00000000			
FR 204.00	5.00000000	20.17008200	1.38447620	--.21091545
FR 204.00	6.00000000	21.45220900	1.18288840	--.19226026
FR 204.00	7.00000000	22.54207800	.99995581	--.17360509
FR 204.00	8.00000000	23.45833900	.83567832	--.15494990
FR 204.00	9.00000000	24.21965200	.69005601	--.13629471
FR 204.00	10.00000000	24.84467000	.56308888	--.11763954
FR 204.00	11.00000000	25.35204800	.45477693	--.09898435

3.12

1.6.0

FR 204.00	12.00000000	25.76044200	.36512017	-.08032918
FR 204.00	13.00000000	26.08691700	.28934827	-.07121463
FR 204.00	14.00000000	26.34217700	.22269091	-.06210008
FR 204.00	15.00000000	26.53533800	.16514810	-.05298555
FR 204.00	16.00000000	26.67551200	.11671977	-.04387100
FR 204.00	17.00000000	26.77181500	.07740603	-.03475646
FR 204.00	18.00000000	26.83336300	.04720690	-.02564191
FR 204.00	19.00000000	26.86926600	.02612226	-.01652736
FR 204.00	20.00000000	26.88864500	.01415210	-.00741283
FR 204.00	21.00000000	26.89925000	.00721934	-.00645246
FR 204.00	22.00000000	26.90340400	.00124713	-.00549211
FR 204.00	23.00000000	26.90206400	-.00376475	-.00453174
FR 204.00	24.00000000	26.89619600	-.00781623	-.00357137
FR 204.00	25.00000000	26.88675100	-.01090776	-.00261102
FR 204.00	26.00000000	26.87470100	-.01303850	-.00165065
FR 204.00	27.00000000	26.86099400	-.01420883	-.00069030
FR 204.00	28.00000000	26.84660300	-.01441883	.00027007
FR 204.00	29.00000000	26.83166400	-.01611070	-.00365395
FR 204.00	30.00000000	26.81307400	-.02172715	-.00757800
FR 204.00	31.00000000	26.78690300	-.03126705	-.01150203
FR 204.00	32.00000000	26.74922800	-.04473103	-.01542608
PEN UP	6000.00000000			
GO TO	4.00000000	26.74922800		

	Y	FIRST DER.	SECOND DER.
IDENT.			
FR 229.50	4.00000000	1.76503680	-.25519756
PEN DOWN	5000.00000000		
FR 229.50	5.00000000	1.52018010	-.23451598
FR 229.50	6.00000000	1.29600480	-.21383439
FR 229.50	7.00000000	1.09251140	-.19315279
FR 229.50	8.00000000	.90969935	-.17247120
FR 229.50	9.00000000	.74756900	-.15178962
FR 229.50	10.00000000	.60612012	-.13110803
FR 229.50	11.00000000	.48535296	-.11042643
FR 229.50	12.00000000	.38526728	-.08974484

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FR 229.50	13.00000000	26.49838800	.30077647	-.07923691
FR 229.50	14.00000000	26.76129800	.22679348	-.06872897
FR 229.50	15.00000000	26.95547900	.16331857	-.05822103
FR 229.50	16.00000000	27.09143800	.11035141	-.04771309
FR 229.50	17.00000000	27.17968400	.06789235	-.03720516
FR 229.50	18.00000000	27.23072500	.03594113	-.02669722
FR 229.50	19.00000000	27.25507000	.01449790	-.01618928
FR 229.50	20.00000000	27.26322300	.00356250	-.00568134
FR 229.50	21.00000000	27.26407600	-.00173058	-.00490500
FR 229.50	22.00000000	27.26002200	-.00624741	-.00412865
FR 229.50	23.00000000	27.25183900	-.00998785	-.00335229
FR 229.50	24.00000000	27.24030500	-.01295190	-.00257594
FR 229.50	25.00000000	27.22619400	-.01513957	-.00179958
FR 229.50	26.00000000	27.21028600	-.01655097	-.00102323
FR 229.50	27.00000000	27.19334900	-.01718636	-.00024688
FR 229.50	28.00000000	27.17617100	-.01704502	.00052946
FR 229.50	29.00000000	27.15940300	-.01648233	.00059563
FR 229.50	30.00000000	27.14323000	-.01585367	.00066180
FR 229.50	31.00000000	27.12771600	-.01515853	.00072798
FR 229.50	32.00000000	27.11293600	-.01439753	.00079415
PEN UP	6000.00000000			
GO TO	4.00000000	27.11293600		

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IDENT.	X	Y	FIRST DER.	SECOND DER.
WL 4.00	0.00000000	3.59374000	.08201932	-.00011969
PEN DOWN 5000.00000000				
WL 4.00	5.10000000	4.01064440	.08150452	-.00008218
WL 4.00	10.20000000	4.42541120	.08118099	-.00004468
WL 4.00	15.30000000	4.83901580	.08104873	-.00000718
WL 4.00	20.40000000	5.25243350	.08110774	.00003032
WL 4.00	25.50000000	5.66663990	.08135801	.00006782
WL 4.00	30.60000000	6.08261040	.08179956	.00010532
WL 4.00	35.70000000	6.50132060	.08243237	.00014283
WL 4.00	40.80000000	6.92374590	.08325646	.00018033
WL 4.00	45.90000000	7.35086170	.08427180	.00021784
WL 4.00	51.00000000	7.78364360	.08547842	.00025534
WL 4.00	56.10000000	8.22278340	.08670952	.00022743
WL 4.00	61.20000000	8.66783860	.08779828	.00019952
WL 4.00	66.30000000	9.11808380	.08874471	.00017162
WL 4.00	71.40000000	9.57279280	.08954882	.00014371
WL 4.00	76.50000000	10.03124000	.09021060	.00011580
WL 4.00	81.60000000	10.49269900	.09073006	.00008789
WL 4.00	86.70000000	10.95644500	.09110718	.00005999
WL 4.00	91.80000000	11.42175100	.09134198	.00003208
WL 4.00	96.90000000	11.88789200	.09144345	.00000417
WL 4.00	102.00000000	12.35413900	.09138459	-.00002372
WL 4.00	107.10000000	12.81950300	.09103407	-.00011373
WL 4.00	112.20000000	13.28190700	.09022454	-.00020373
WL 4.00	117.30000000	13.73901400	.08895601	-.00029373
WL 4.00	122.40000000	14.18847800	.08722847	-.00038373
WL 4.00	127.50000000	14.62796200	.08504193	-.00047373
WL 4.00	132.60000000	15.05512500	.08239638	-.00056373
WL 4.00	137.70000000	15.46762700	.07929182	-.00065373
WL 4.00	142.80000000	15.86312200	.07572827	-.00074373
WL 4.00	147.90000000	16.23927400	.07170570	-.00083373

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WL	4.00	153.00000000	16.50374100	.06722413	-.00092373
WL	4.00	158.10000000	16.92442600	.06242847	-.00095691
WL	4.00	163.20000000	17.23022200	.05746362	-.00099008
WL	4.00	168.30000000	17.51026600	.05232958	-.00102326
WL	4.00	173.40000000	17.76369700	.04702636	-.00105643
WL	4.00	178.50000000	17.98964900	.04155395	-.00108960
WL	4.00	183.60000000	18.18725900	.03591235	-.00112278
WL	4.00	188.70000000	18.35566700	.03010158	-.00115595
WL	4.00	193.80000000	18.49400800	.02412162	-.00118912
WL	4.00	198.90000000	18.60142100	.01797247	-.00122230
WL	4.00	204.00000000	18.67703900	.01165413	-.00125547
WL	4.00	209.10000000	18.71912200	.00464606	-.00149278
WL	4.00	214.20000000	18.72237200	-.00357231	-.00173010
WL	4.00	219.30000000	18.68062600	-.01300098	-.00196741
WL	4.00	224.40000000	18.58770400	-.02363994	-.00220472
WL	4.00	229.50000000	18.43744000	-.03548918	-.00244204
PEN UP	6000.00000000				
GO TO	0.00000000		18.43744000		

IDENT.	X	Y	FIRST DER.	SECOND DER.
WL	8.00	0.00000000	.14400793	-.00174746
PEN DOWN	5000.00000000	4.27383460		
WL	8.00	5.10000000	.13567074	-.00152202
WL	8.00	10.20000000	.12848329	-.00129658
WL	8.00	15.30000000	.12244557	-.00107114
WL	8.00	20.40000000	.11755758	-.00084570
WL	8.00	25.50000000	.11381933	-.00062027
WL	8.00	30.60000000	.11123082	-.00039483
WL	8.00	35.70000000	.10979205	-.00016939
WL	8.00	40.80000000	.10950300	-.00005604
WL	8.00	45.90000000	.11036369	-.00028148
WL	8.00	51.00000000	.11237412	-.00050692
WL	8.00	56.10000000	.11468693	-.00040006
WL	8.00	61.20000000	.11645476	-.00029320

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WL	8.00	66.30000000	12.08908900	.11767761	.00018634
WL	8.00	71.40000000	12.69120400	.11835549	.00007948
WL	8.00	76.50000000	13.29538800	.11848838	-.00002737
WL	8.00	81.60000000	13.89886000	.11807630	-.00013422
WL	8.00	86.70000000	14.49883900	.11711925	-.00024108
WL	8.00	91.80000000	15.09255000	.11561722	-.00034794
WL	8.00	96.90000000	15.67720900	.11357020	-.00045480
WL	8.00	102.00000000	16.25004000	.11097822	-.00056166
WL	8.00	107.10000000	16.80854300	.10800820	-.00060305
WL	8.00	112.20000000	17.35136300	.10482705	-.00064445
WL	8.00	117.30000000	17.87742200	.10143479	-.00068584
WL	8.00	122.40000000	18.38564000	.09783140	-.00072724
WL	8.00	127.50000000	18.87494300	.09401690	-.00076863
WL	8.00	132.60000000	19.34425400	.08999131	-.00081003
WL	8.00	137.70000000	19.79249600	.08575460	-.00085142
WL	8.00	142.80000000	20.21859100	.08130676	-.00089282
WL	8.00	147.90000000	20.62146600	.07664780	-.00093421
WL	8.00	153.00000000	21.00004000	.07177772	-.00097561
WL	8.00	158.10000000	21.35348300	.06684118	-.00096029
WL	8.00	163.20000000	21.68195200	.06198277	-.00094496
WL	8.00	168.30000000	21.98584200	.05720253	-.00092964
WL	8.00	173.40000000	22.26555100	.05250038	-.00091432
WL	8.00	178.50000000	22.52147800	.04787641	-.00089900
WL	8.00	183.60000000	22.75402400	.04333054	-.00088367
WL	8.00	188.70000000	22.963358400	.03886281	-.00086835
WL	8.00	193.80000000	23.15055900	.03447332	-.00085303
WL	8.00	198.90000000	23.31534500	.03016187	-.00083771
WL	8.00	204.00000000	23.45834300	.02592866	-.00082239
WL	8.00	209.10000000	23.57848000	.02090837	-.00114632
WL	8.00	214.20000000	23.66880000	.01423618	-.00147025
WL	8.00	219.30000000	23.72088100	.00591184	-.00179418
WL	8.00	224.40000000	23.72629300	-.00406451	-.00211811
WL	8.00	229.50000000	23.67661800	-.01569286	-.00244204
PEN UP		6000.00000000			
GO TO		0.00000000	23.67661800		
		4.95392930			
		7.17320510			
		-.56204280			
		.21614780			
		-.51108100			
		.07579290			

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.46576080 -1.88656440		X		Y	FIRST DER.	SECOND DER.
IDENT.						
WL	12.00	0.00000000		4.95392930	.14065108	-.00043217
PEN	DOWN	5000.00000000				
WL	12.00	5.10000000		5.66584550	.13657413	-.00038231
WL	12.00	10.20000000		6.36781770	.13675148	-.00033245
WL	12.00	15.30000000		7.06114290	.13518312	-.00028259
WL	12.00	20.40000000		7.74711790	.13386905	-.00023273
WL	12.00	25.50000000		8.42703950	.13280927	-.00018286
WL	12.00	30.60000000		9.10220480	.13200379	-.00013300
WL	12.00	35.70000000		9.77391050	.13145259	-.00008314
WL	12.00	40.80000000		10.44345300	.13115569	-.00003328
WL	12.00	45.90000000		11.11213000	.13111308	-.00001657
WL	12.00	51.00000000		11.78123900	.13132476	.00006643
WL	12.00	56.10000000		12.45156400	.13149010	-.00000159
WL	12.00	61.20000000		13.12184900	.13130845	-.00006963
WL	12.00	66.30000000		13.79032000	.13077983	-.00013766
WL	12.00	71.40000000		14.45521300	.12990422	-.00020570
WL	12.00	76.50000000		15.11475300	.12868163	-.00027374
WL	12.00	81.60000000		15.76717600	.12711207	-.00034177
WL	12.00	86.70000000		16.41070800	.12519552	-.00040981
WL	12.00	91.80000000		17.04358000	.12293200	-.00047784
WL	12.00	96.90000000		17.66402300	.12032149	-.00054588
WL	12.00	102.00000000		18.27026900	.11736400	-.00061391
WL	12.00	107.10000000		18.86062200	.11410412	-.00066446
WL	12.00	112.20000000		19.43369300	.11058642	-.00071501
WL	12.00	117.30000000		19.98816600	.10681092	-.00076557
WL	12.00	122.40000000		20.52272600	.10277760	-.00081612
WL	12.00	127.50000000		21.03605900	.09844867	-.00086667
WL	12.00	132.60000000		21.52685000	.09393753	-.00091722
WL	12.00	137.70000000		21.99378400	.08913077	-.00096777
WL	12.00	142.80000000		22.43554500	.08406620	-.00101832
WL	12.00	147.90000000		22.85082100	.07874382	-.00106887
WL	12.00	153.00000000		23.23829300	.07316363	-.00111943
WL	12.00	158.10000000		23.59711600	.06759960	-.00106254
WL	12.00	163.20000000		23.92830400	.06232571	-.00100564
WL	12.00	168.30000000		24.23333300	.05734198	-.00094875
WL	12.00	173.40000000		24.51368500	.05264837	-.00089186
WL	12.00	178.50000000		24.77083900	.04824493	-.00083497
WL	12.00	183.60000000		25.00627600	.04413160	-.00077808

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1.6.0

WL 12.00	188.70000000	25.22147400	.04030842	-.00072119
WL 12.00	193.80000000	25.41791600	.03677538	-.00066430
WL 12.00	198.90000000	25.59707700	.03353250	-.00060741
WL 12.00	204.00000000	25.76044000	.03057972	-.00055052
WL 12.00	209.10000000	25.90759700	.02680738	-.00092882
WL 12.00	214.20000000	26.03059600	.02110568	-.00130713
WL 12.00	219.30000000	26.11959600	.01347465	-.00168543
WL 12.00	224.40000000	26.16475800	.00391423	-.00206373
WL 12.00	229.50000000	26.15624200	-.00757549	-.00244204
PEN UP	6000.00000000			
GO TO	0.00000000	26.15624200		

5.63642650
6.71973260
1.06098500
-.50050526
.30749127
.05869193
.44494005
-2.10074160

IDENT.		X
WL 16.00	0.00000000	
PEN DOWN	5000.00000000	
WL 16.00	5.10000000	
WL 16.00	10.20000000	
WL 16.00	15.30000000	
WL 16.00	20.40000000	
WL 16.00	25.50000000	
WL 16.00	30.60000000	
WL 16.00	35.70000000	
WL 16.00	40.80000000	
WL 16.00	45.90000000	
WL 16.00	51.00000000	
WL 16.00	56.10000000	
WL 16.00	61.20000000	
WL 16.00	66.30000000	
WL 16.00	71.40000000	
WL 16.00	76.50000000	
WL 16.00	81.60000000	
WL 16.00	86.70000000	
WL 16.00	91.80000000	
WL 16.00	96.90000000	

FIRST DER.	SECOND DER.
.13175946	.00081582
.13562577	.00070037
.13890325	.00058491
.14159190	.00046945
.14369172	.00035400
.14520271	.00023854
.14612488	.00012308
.14645821	.00000763
.14620271	.00010782
.14535839	.00022328
.14392523	.00033873
.14208412	.00038326
.14001594	.00042778
.13772068	.00047231
.13519834	.00051683
.13244893	.00056136
.12947244	.00060588
.12626888	.00065041
.12283825	.00069493
.11918054	.00073946

3.19

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WL	16.00	102.00000000	19.62328000	.11529576	-.00078398
WL	16.00	107.10000000	20.20095600	.11121841	-.00081497
WL	16.00	112.20000000	20.75743700	.10698306	-.00084595
WL	16.00	117.30000000	21.29191500	.10258965	-.00087694
WL	16.00	122.40000000	21.80358500	.09803824	-.00090792
WL	16.00	127.50000000	22.29163800	.09332880	-.00093891
WL	16.00	132.60000000	22.75526900	.08846133	-.00096989
WL	16.00	137.70000000	23.19367400	.08343585	-.00100088
WL	16.00	142.80000000	23.60604700	.07825234	-.00103186
WL	16.00	147.90000000	23.99157900	.07291079	-.00106285
WL	16.00	153.00000000	24.34946700	.06741121	-.00109383
WL	16.00	158.10000000	24.67934800	.06201536	-.00102218
WL	16.00	163.20000000	24.98264500	.05698492	-.00095053
WL	16.00	168.30000000	25.26121700	.05231992	-.00087887
WL	16.00	173.40000000	25.51692900	.04802034	-.00080722
WL	16.00	178.50000000	25.75164600	.04408621	-.00073557
WL	16.00	183.60000000	25.96723000	.04051751	-.00066391
WL	16.00	188.70000000	26.16554500	.03731425	-.00059226
WL	16.00	193.80000000	26.34845600	.03447641	-.00052061
WL	16.00	198.90000000	26.51782500	.03200400	-.00044895
WL	16.00	204.00000000	26.67551900	.02989702	-.00037730
WL	16.00	209.10000000	26.82129500	.02691977	-.00079025
WL	16.00	214.20000000	26.94651900	.02183646	-.00120319
WL	16.00	219.30000000	27.04044700	.01464712	-.00161614
WL	16.00	224.40000000	27.09233900	.00535180	-.00202909
WL	16.00	229.50000000	27.09145600	-.00604957	-.00244203
PEN UP		6000.00000000			
GO TO		0.00000000	27.09145600		

6.33333990
7.02091200
1.53023220
-.81131490
.68568920
.13724840
.30044840
-2.22299730

IDENT. X
WL 20.00 0.00000000
PEN DOWN 5000.00000000
WL 20.00 5.10000000
WL 20.00 10.20000000

FIRST DER.
.13766494
.14318860
.14775778
SECOND DER.
.00117664
.00098949
.00080234

Y
6.33333990
7.04992210
7.79224100

18.90

1. 6. 0

WL	20.00	15.30000000	8.55542880	.15137247	.00061518
WL	20.00	20.40000000	9.33461770	.15403267	.00042803
WL	20.00	25.50000000	10.12493900	.15573839	.00024087
WL	20.00	30.60000000	10.92152600	.15648961	.00005372
WL	20.00	35.70000000	11.71451000	.15628635	.00013343
WL	20.00	40.80000000	12.51402400	.15512860	.00032058
WL	20.00	45.90000000	13.30020000	.15301636	.00050774
WL	20.00	51.00000000	14.07316900	.14994964	.00069489
WL	20.00	56.10000000	14.82874800	.14633175	.00072387
WL	20.00	61.20000000	15.56550100	.14256611	.00075285
WL	20.00	66.30000000	16.28267200	.13865264	.00078183
WL	20.00	71.40000000	16.97950700	.13459140	.00081081
WL	20.00	76.50000000	17.65525300	.13038235	.00083979
WL	20.00	81.60000000	18.30915500	.12602551	.00086877
WL	20.00	86.70000000	18.94046000	.12152086	.00089775
WL	20.00	91.80000000	19.54841600	.11686843	.00092673
WL	20.00	96.90000000	20.13226800	.11206820	.00095571
WL	20.00	102.00000000	20.69126100	.10712018	.00098469
WL	20.00	107.10000000	21.22477900	.10210511	.00098200
WL	20.00	112.20000000	21.73275400	.09710368	.00097932
WL	20.00	117.30000000	22.21526000	.09211596	.00097664
WL	20.00	122.40000000	22.67236100	.08714189	.00097396
WL	20.00	127.50000000	23.10413200	.08218151	.00097128
WL	20.00	132.60000000	23.51063600	.07723478	.00096860
WL	20.00	137.70000000	23.89194900	.07230175	.00096592
WL	20.00	142.80000000	24.24813800	.06738239	.00096324
WL	20.00	147.90000000	24.57927200	.06247669	.00096056
WL	20.00	153.00000000	24.88542300	.05758467	.00095787
WL	20.00	158.10000000	25.16695900	.05288306	.00088589
WL	20.00	163.20000000	25.42545400	.04854860	.00081390
WL	20.00	168.30000000	25.66277900	.04458126	.00074191
WL	20.00	173.40000000	25.88080600	.04098107	.00066992
WL	20.00	178.50000000	26.08141100	.03774803	.00059793
WL	20.00	183.60000000	26.26646200	.03488211	.00052594
WL	20.00	188.70000000	26.43783200	.03238338	.00045395
WL	20.00	193.80000000	26.59739500	.03025175	.00038196
WL	20.00	198.90000000	26.74702300	.02848730	.00030998
WL	20.00	204.00000000	26.88859200	.02708996	.00023799
WL	20.00	209.10000000	27.02174400	.02475213	.00067880
WL	20.00	214.20000000	27.13724000	.02016621	.00111961
WL	20.00	219.30000000	27.22361800	.01333204	.00156043

B. 21

1. 9. 0

WL	20.00	224.40000000	27.26940600	-00424980	-00200124
WL	20.00	229.50000000	27.26314400	-00708066	-00244205
PEN UP	6000.00000000				
GO TO	0.00000000		27.26314400		

7.05444240
8.59809330
.38428388
-.59693068
.61769343
.07666455
.21331101
-2.34795840

IDENT.		X
WL	24.00	0.00000000
PEN DOWN	5000.00000000	
WL	24.00	5.10000000
WL	24.00	10.20000000
WL	24.00	15.30000000
WL	24.00	20.40000000
WL	24.00	25.50000000
WL	24.00	30.60000000
WL	24.00	35.70000000
WL	24.00	40.80000000
WL	24.00	45.90000000
WL	24.00	51.00000000
WL	24.00	56.10000000
WL	24.00	61.20000000
WL	24.00	66.30000000
WL	24.00	71.40000000
WL	24.00	76.50000000
WL	24.00	81.60000000
WL	24.00	86.70000000
WL	24.00	91.80000000
WL	24.00	96.90000000
WL	24.00	102.00000000
WL	24.00	107.10000000
WL	24.00	112.20000000
WL	24.00	117.30000000
WL	24.00	122.40000000
WL	24.00	127.50000000
WL	24.00	132.60000000

FIRST DER.	SECOND DER.
.16859006	.00029548
.16974592	.00015778
.17019951	.00002008
.16995083	-.00011761
.16899987	-.00025531
.16734664	-.00039301
.16499115	-.00053071
.16193338	-.00066841
.15817334	-.00080611
.15371103	-.00094381
.14854645	-.00108151
.14304294	-.00107672
.13756397	-.00107193
.13210921	-.00106714
.12667899	-.00106235
.12127319	-.00105756
.11589182	-.00105277
.11053487	-.00104798
.10520236	-.00104319
.09989427	-.00103840
.09461059	-.00103361
.08939646	-.00101114
.08429694	-.00098866
.07931205	-.00096619
.07444176	-.00094371
.06968609	-.00092124
.06504507	-.00089877

Y
7.05444240
7.91749760
8.78465690
9.65233870
10.51696100
11.37494300
12.22270300
13.05665900
13.87323000
14.66883300
15.43988800
16.18343100
16.89896600
17.58662300
18.24652300
18.87878900
19.48355000
20.06092800
20.61104800
21.13403400
21.63001100
22.09917800
22.54205000
22.95920300
23.35122700
23.71870600
24.06222100

0. 2. 2

1.6.0

WL	24.00	137.70000000	24.38235800	.06051865	--.00087629
WL	24.00	142.80000000	24.67970600	.05610685	--.00085382
WL	24.00	147.90000000	24.95484400	.05180967	--.00083134
WL	24.00	153.00000000	25.20835800	.04762710	--.00080887
WL	24.00	158.10000000	25.44104900	.04368465	--.00073719
WL	24.00	163.20000000	25.65456300	.04010776	--.00066550
WL	24.00	168.30000000	25.85076900	.03689645	--.00059382
WL	24.00	173.40000000	26.03152800	.03405070	--.00052214
WL	24.00	178.50000000	26.19870700	.03157054	--.00045046
WL	24.00	183.60000000	26.35416900	.02945597	--.00037878
WL	24.00	188.70000000	26.49978000	.02770695	--.00030710
WL	24.00	193.80000000	26.63740300	.02632350	--.00023542
WL	24.00	198.90000000	26.76890100	.02530564	--.00016374
WL	24.00	204.00000000	26.89614300	.02465334	--.00009205
WL	24.00	209.10000000	27.01863900	.02298549	--.00056200
WL	24.00	214.20000000	27.12652000	.01892089	--.00103195
WL	24.00	219.30000000	27.20755900	.01245955	--.00150190
WL	24.00	224.40000000	27.24953200	.00360151	--.00197184
WL	24.00	229.50000000	27.24021900	--.00765327	--.00244179
PEN UP	6000.00000000				
GO TO	7.79093680		27.24021900		

11.92372400
 -3.26748000
 .55285218
 -.47524960
 .13092940
 .04237003
 -2.56779030

IDENT.		X		FIRST DER.	SECOND DER.
WL	28.00	0.00000000	7.79093680	.23379850	--.00251247
PEN DOWN	5000.00000000				
WL	28.00	5.10000000	8.95118720	.22131005	--.00238494
WL	28.00	10.20000000	10.04940400	.20947203	--.00225741
WL	28.00	15.30000000	11.08890800	.19828443	--.00212988
WL	28.00	20.40000000	12.07301200	.18774723	--.00200235
WL	28.00	25.50000000	13.00503400	.17786045	--.00187481
WL	28.00	30.60000000	13.88829500	.16862408	--.00174728
WL	28.00	35.70000000	14.72610600	.16003812	--.00161975
WL	28.00	40.80000000	15.52178900	.15210259	--.00149222
WL	28.00	45.90000000	16.27865800	.14481746	--.00136468

1.5.0

WL	28.00	51.00000000	17.00003200	.13818275	-.00123715
WL	28.00	56.10000000	17.68875300	.13191890	-.00121925
WL	28.00	61.20000000	18.34576000	.12574634	-.00120135
WL	28.00	66.30000000	18.97152100	.11966508	-.00118345
WL	28.00	71.40000000	19.56650000	.11367511	-.00116555
WL	28.00	76.50000000	20.13116200	.10777644	-.00114765
WL	28.00	81.60000000	20.66597500	.10196908	-.00112974
WL	28.00	86.70000000	21.17140100	.09625300	-.00111184
WL	28.00	91.80000000	21.64791000	.09062823	-.00109394
WL	26.00	96.90000000	22.09596600	.08509475	-.00107604
WL	28.00	102.00000000	22.51603200	.07965257	-.00105814
WL	28.00	107.10000000	22.90870700	.07437870	-.00101003
WL	28.00	112.20000000	23.27511100	.06935017	-.00096193
WL	28.00	117.30000000	23.61649600	.06456696	-.00091383
WL	28.00	122.40000000	23.93411200	.06002909	-.00086572
WL	28.00	127.50000000	24.22921000	.05573655	-.00081762
WL	28.00	132.60000000	24.50304100	.05168932	-.00076951
WL	28.00	137.70000000	24.75685700	.04788745	-.00072141
WL	28.00	142.80000000	24.99191100	.04433090	-.00067330
WL	28.00	147.90000000	25.20945000	.04101971	-.00062520
WL	28.00	153.00000000	25.41072900	.03795382	-.00057710
WL	28.00	158.10000000	25.59704000	.03515818	-.00051922
WL	28.00	163.20000000	25.76984400	.03265775	-.00046134
WL	28.00	168.30000000	25.93064900	.03045248	-.00040346
WL	28.00	173.40000000	26.08096200	.02854240	-.00034558
WL	28.00	178.50000000	26.22228400	.02692746	-.00028771
WL	28.00	183.60000000	26.35612400	.02560775	-.00022983
WL	28.00	188.70000000	26.48398500	.02458320	-.00017195
WL	28.00	193.80000000	26.60737400	.02385382	-.00011407
WL	28.00	198.90000000	26.72779600	.02341963	-.00005619
WL	28.00	204.00000000	26.84675700	.02328062	.00000168
WL	28.00	209.10000000	26.96339500	.02204396	-.00048664
WL	28.00	214.20000000	27.06737200	.01831685	-.00097496
WL	28.00	219.30000000	27.14599200	.01209927	-.00146329
WL	28.00	224.40000000	27.18655200	.00339124	-.00195161
WL	28.00	229.50000000	27.17634800	-.00780723	-.00243994
PEN UP		6000.00000000			
GO TO		0.00000000	27.17634800		
		8.53129730			
		18.14805900			
		-10.99630700			

B-24

1. 5. 0

3.23360700
-3.31511150
-58047877
-51939716
-2.02109770

IDENT.	WL	32.00	0.00000000	X
PEN DOWN	5000.00000000			
WL	32.00	5.10000000		
WL	32.00	10.20000000		
WL	32.00	15.30000000		
WL	32.00	20.40000000		
WL	32.00	25.50000000		
WL	32.00	30.60000000		
WL	32.00	35.70000000		
WL	32.00	40.80000000		
WL	32.00	45.90000000		
WL	32.00	51.00000000		
WL	32.00	56.10000000		
WL	32.00	61.20000000		
WL	32.00	66.30000000		
WL	32.00	71.40000000		
WL	32.00	76.50000000		
WL	32.00	81.60000000		
WL	32.00	86.70000000		
WL	32.00	91.80000000		
WL	32.00	96.90000000		
WL	32.00	102.00000000		
WL	32.00	107.10000000		
WL	32.00	112.20000000		
WL	32.00	117.30000000		
WL	32.00	122.40000000		
WL	32.00	127.50000000		
WL	32.00	132.60000000		
WL	32.00	137.70000000		
WL	32.00	142.80000000		
WL	32.00	147.90000000		
WL	32.00	153.00000000		
WL	32.00	158.10000000		
WL	32.00	163.20000000		
WL	32.00	168.30000000		

Y
8.53129730
10.23937300
11.74692500
13.07335500
14.23806100
15.26045000
16.15992100
16.95587500
17.66771400
18.31484100
18.91665600
19.48924600
20.03543800
20.55474100
21.04666900
21.51073000
21.94643600
22.35330000
22.73082900
23.07853600
23.39593200
23.68310900
23.94247900
24.17703800
24.38978000
24.58369400
24.76177900
24.92702900
25.08243200
25.23098800
25.37568600
25.51900700
25.66133500
25.80256700

FIRST DER.	SECOND DER.
.35584429	-.00845544
.31462364	-.00770951
.27720723	-.00696358
.24359505	-.00621765
.21378715	-.00547172
.18778347	-.00472579
.16558404	-.00397986
.14718886	-.00323393
.13259790	-.00248800
.12181121	-.00174207
.11482874	-.00099614
.10970046	-.00101494
.10447630	-.00103374
.09915623	-.00105254
.09374028	-.00107135
.08822843	-.00109015
.08262071	-.00110895
.07691711	-.00112775
.07111760	-.00114655
.06522225	-.00116535
.05923100	-.00118415
.05348530	-.00106905
.04832663	-.00095395
.04375496	-.00083884
.03977036	-.00072374
.03637276	-.00060864
.03356219	-.00049353
.03133868	-.00037843
.02970216	-.00026333
.02865269	-.00014822
.02819028	-.00003312
.02800933	-.00003783
.02780438	-.00004254
.02757531	-.00004725

B. 20

1. 9. 0

WL 32.00	173.40000000	25.94256100	-02732232	--.00005196
WL 32.00	178.50000000	26.08122400	-02704517	--.00005667
WL 32.00	183.60000000	26.21838300	-02674405	--.00006139
WL 32.00	188.70000000	26.35397000	-02641900	--.00006610
WL 32.00	193.80000000	26.48782400	-02606998	--.00007081
WL 32.00	198.90000000	26.61984300	-02569680	--.00007552
WL 32.00	204.00000000	26.74988300	-02529968	--.00008023
WL 32.00	209.10000000	26.87583500	-02368971	--.00055117
WL 32.00	214.20000000	26.98744100	-01967792	--.00102211
WL 32.00	219.30000000	27.07247100	-01326388	--.00149305
WL 32.00	224.40000000	27.11864300	-00444864	--.00196399
WL 32.00	229.50000000	27.11375800	-00676858	--.00243492
PEN UP	6000.00000000			
GO TO	0.00000000			

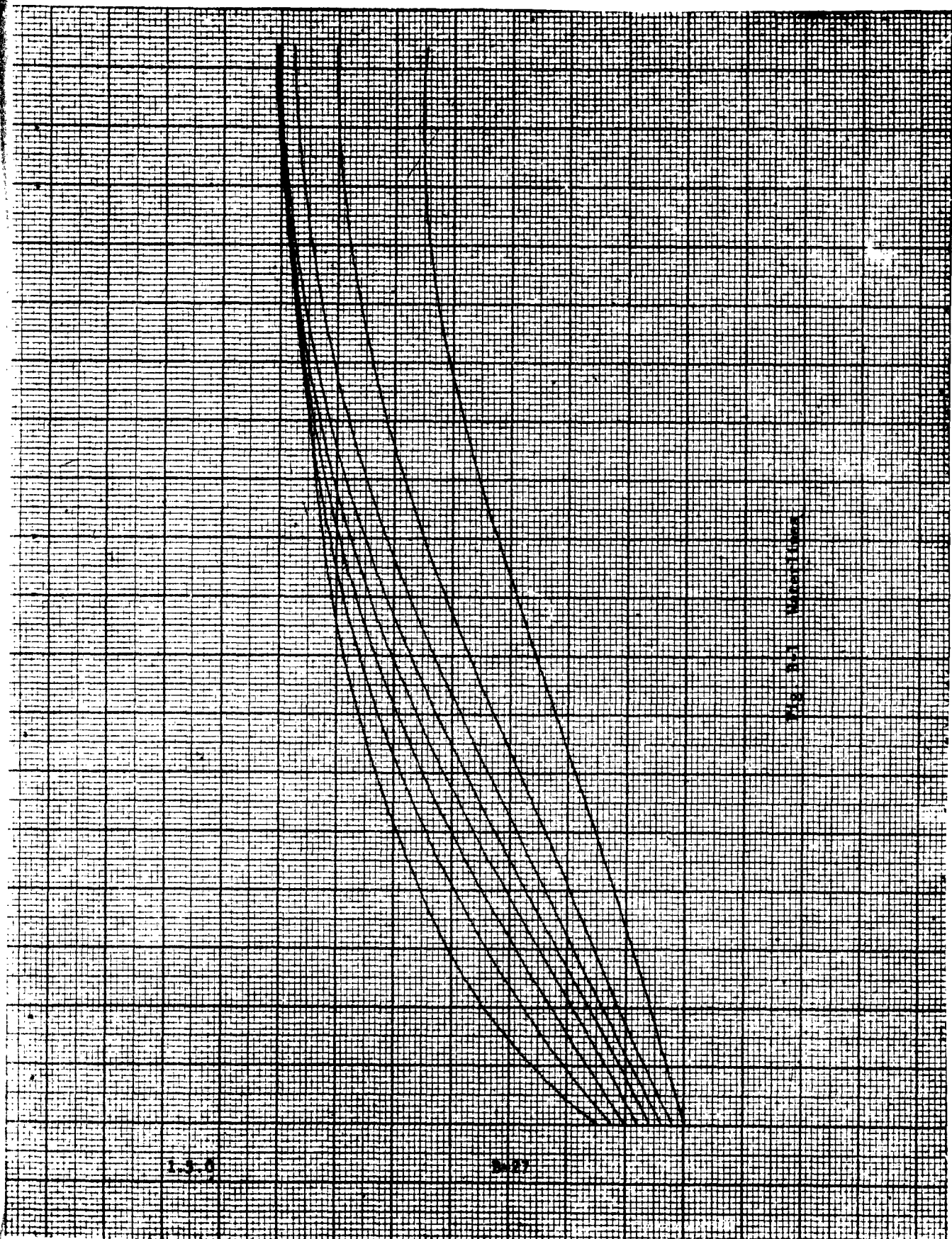
3.59374000
1.36018930
0.00000000
0.00000000
-01922132
-03714167
-01531844

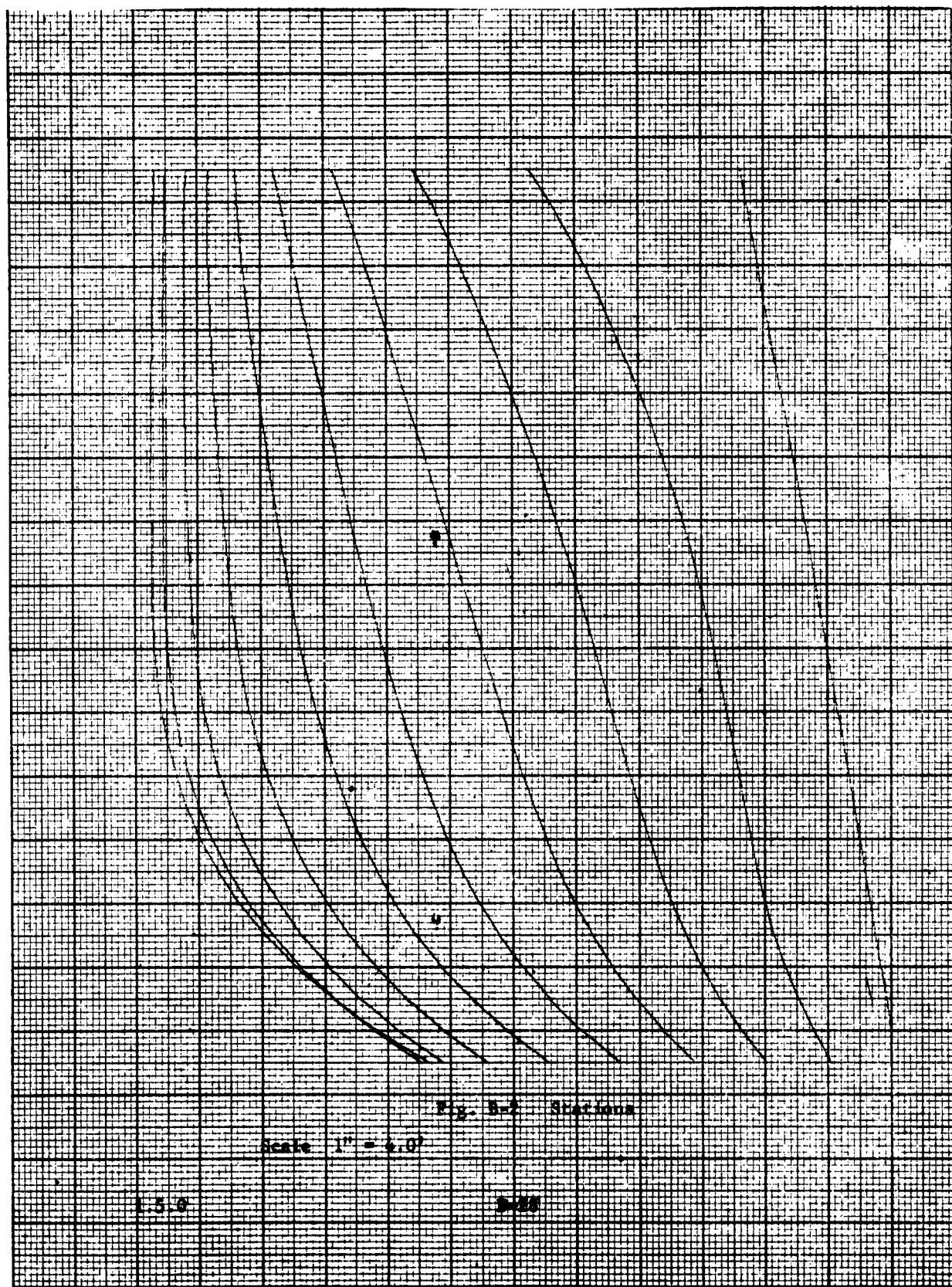
IDENT.
FR 0.00 4.00000000
PEN DOWN 5000.00000000

Y
3.59374000

FIRST DER.
.17002366

SECOND DER.
0.00000000





UPPER BOW SECTION OF DLG-26

Project:

To fair the extreme forward section of the DLG-26, including the end profile above Waterline 16, for the purpose of testing the ability of the end profile fairing formulation

Data:

The data was the preliminary offsets of DLG-26 on Stations 0, 1/2, 1, 1-1/2, 2, at Waterlines 16, 20, 24, 28, 32, 36, and 40. The surface was re-faired slightly to eliminate the knuckle. In addition, the offsets which describe the bow profile in this area were used.

Procedure:

The profile of the bow above the sixteen-foot waterline was determined to be a straight line and its equation was found. The equation and the preliminary offsets were entered into SMOG-2. This program punched the LP matrix in the end profile formulation using the λ fit and dual tableau on the IBM-1620. The surface was faired on the IBM-7090 using LP-90 in approximately fifteen minutes. The results were then solved for on the 1620 using GOBACK 2 and plotted as shown.

Results:

The faired surface went exactly through the profile equation. The surface seems to be completely fair but shows a slight hook at the extreme ends of the waterlines. This may require some adjustment of the profile turn.

DLG	26	BOW	PRELIMINARY OFFSETS	
2.0				
	.0000	.000000		
	1.0000	1.239583		
	2.0000	2.697916		
	3.0000	4.197916		
	4.0000	5.812500		
2.5				
	.0000	.078000		
	1.0000	1.479166		
	2.0000	2.979166		
	3.0000	4.583333		
	4.0000	6.333333		
3.0				
	.0000	.343749		
	1.0000	1.791666		
	2.0000	3.447916		
	3.0000	5.250000		
	4.0000	7.166666		
3.5				
	.0000	.708333		
	1.0000	2.416666		
	2.0000	4.322916		
	3.0000	6.416666		
	4.0000	8.583333		
4.0				
	.0000	1.343749		
	1.0000	3.531250		
	2.0000	5.864583		
	3.0000	8.250000		
	4.0000	10.750000		
4.5				
	.0000	2.312500		
	1.0000	5.145833		
	2.0000	8.000000		
	3.0000	10.802083		
	4.0000	13.510416		
5.0				
	.0000	3.697916		
	1.0000	7.135416		
	2.0000	10.52063		
	3.0000	13.9		
	4.0000	16.68749		
1.0		1.0	0.0	0.0

DLG 26 BOW PROFILE 7 X 5 STATION OFFSETS

IDENT.	FR	PN	DOWN	Z	Y	1ST DER.	2ND DER.
	-0.50	29.00	00781250		0.00000000	0.00000000	0.00000000
		PN	DOWN	5000.00	00000000		
	-0.50	30.00	00781250		-0.01241726	0.06133707	0.02999484
	-0.50	31.00	00781250		-0.06838928	0.09488421	0.02510153
	-0.50	32.00	00000000		0.18265904	0.12337569	0.02508706
	-0.50	32.00	00781250		0.18367777	0.12359445	0.02507798
	-0.50	33.00	00781250		0.32827435	0.15043581	0.02404715
	-0.50	34.00	00781250		0.49886258	0.17528991	0.02311983
	-0.50	35.00	00781250		0.69267447	0.19844057	0.02224496
	-0.50	36.00	00781250		0.90746497	0.22014958	0.02148276
	-0.50	37.00	00781250		1.14158602	0.24079723	0.02094894
	-0.50	38.00	00781250		1.39423076	0.26096504	0.02079921
	-0.50	39.00	00781250		1.66578873	0.28149525	0.02121887
	-0.50	40.00	00000000		1.95559456	0.30272257	0.02148540
		PN	UP	6000.00	00000000		
		GO	TO	16.00	00000000		

-0.19857018
 0.86080928
 -0.63872110
 0.30943566
 -0.12540561
 -0.31318475

IDENT.	FR	PN	DOWN	Z	Y	1ST DER.	2ND DER.
	0.00	18.80	468750		0.00000000	0.00000000	0.00000000
		PN	DOWN	5000.00	00000000		
	0.00	19.80	468750		0.06412827	0.04685365	0.00326694
	0.00	20.80	468750		0.12146806	0.04995185	0.00150935
	0.00	21.80	468750		0.17999151	0.05250239	0.00293430
	0.00	22.80	468750		0.24064737	0.05682068	0.00555439
	0.00	23.80	468750		0.30579310	0.06386893	0.00870399
	0.00	24.00	00000000		0.31929059	0.06560569	0.00935178
	0.00	24.80	468750		0.37829853	0.07360382	0.01091786
	0.00	25.80	468750		0.46038739	0.08522280	0.01289397

FR	0.00	26.80468750	.55399413	.00877085	.01491106
FR	0.00	27.80468750	.66123297	.11438730	.01702527
FR	0.00	28.80468750	.78457756	.13234689	.01934174
FR	0.00	29.80468750	.92697687	.15282182	.02156796
FR	0.00	30.80468750	1.09094210	.17546808	.02372456
FR	0.00	31.80468750	1.27863190	.20027094	.02588116
FR	0.00	32.00000000	1.31824365	.20536699	.02630237
FR	0.00	32.80468750	1.49188414	.22604216	.02508445
FR	0.00	33.80468750	1.73021628	.25036985	.02357092
FR	0.00	34.80468750	1.99211935	.27318401	.02205739
FR	0.00	35.80468750	2.27607980	.29448464	.02054386
FR	0.00	36.80468750	2.58058412	.31427173	.01903032
FR	0.00	37.80468750	2.90411877	.33254530	.01751679
FR	0.00	38.80468750	3.24517021	.34930533	.01600326
FR	0.00	39.80468750	3.60222492	.36455183	.01448973
FR	0.00	40.00000000	3.67370095	.36735299	.01419412
PN UP	6000.00000000				
GO TO	16.00000000				

1.21408366
 .77772376
 -.61082310
 .43533247
 -.26726459
 -.55579327

IDENT.	Z
FR 1.00	16.00000000
PN DOWN	5000.00000000
FR 1.00	17.00000000
FR 1.00	18.00000000
FR 1.00	19.00000000
FR 1.00	20.00000000
FR 1.00	21.00000000
FR 1.00	22.00000000
FR 1.00	23.00000000
FR 1.00	24.00000000
FR 1.00	25.00000000
FR 1.00	26.00000000
FR 1.00	27.00000000
FR 1.00	28.00000000
FR 1.00	29.00000000
FR 1.00	30.00000000

1ST DER.	2ND DER.
.09721547	-.01908822
.08067802	-.01398666
.06924213	-.00888511
.06290779	-.00378356
.06167500	.00131798
.06554376	.00641954
.07451408	.01152109
.08858595	.01662264
.10775937	.02172419
.13046834	.02369374
.15514685	.02566328
.18179491	.02763283
.21041252	.02960237
.24099967	.03157192
.27355637	.03354147

FR 1.00 31.00000000
 FR 1.00 32.00000000
 FR 1.00 33.00000000
 FR 1.00 34.00000000
 FR 1.00 35.00000000
 FR 1.00 36.00000000
 FR 1.00 37.00000000
 FR 1.00 38.00000000
 FR 1.00 39.00000000
 FR 1.00 40.00000000
 PN UP 6000.00000000
 GO TO 16.00000000

2.67241364
 .74207394
 -.49151906
 .49944512
 -.34696249
 -.63815559

IDENT. Z

FR 2.00 16.00000000
 PN DOWN 5000.00000000
 FR 2.00 17.00000000
 FR 2.00 18.00000000
 FR 2.00 19.00000000
 FR 2.00 20.00000000
 FR 2.00 21.00000000
 FR 2.00 22.00000000
 FR 2.00 23.00000000
 FR 2.00 24.00000000
 FR 2.00 25.00000000
 FR 2.00 26.00000000
 FR 2.00 27.00000000
 FR 2.00 28.00000000
 FR 2.00 29.00000000
 FR 2.00 30.00000000
 FR 2.00 31.00000000
 FR 2.00 32.00000000
 FR 2.00 33.00000000
 FR 2.00 34.00000000
 FR 2.00 35.00000000
 FR 2.00 36.00000000

3.21546756
 3.54163395
 3.90419535
 4.29969367
 4.72358522
 5.17152637
 5.63837346
 6.12018282
 6.61221079
 7.10991374
 7.10991374

.30808261
 .34457840
 .37978713
 .41045221
 .43657363
 .45815139
 .47518549
 .48767594
 .49562273
 .49902587
 .03551101
 .03748056
 .03293690
 .02839324
 .02384959
 .01930593
 .01476227
 .01021861
 .00567496
 .00113130

Y

1ST DER.
 .09275924

2ND DER.
 -.01535997

2.67241364
 2.75846837
 2.83501601
 2.90790942
 2.98300148
 3.06614506
 3.16319303
 3.27999826
 3.42241364
 3.59561435
 3.80206499
 4.04355245
 4.32186363
 4.63878544
 4.99610480
 5.39560860
 5.83908375
 6.32707075
 6.85512453
 7.41755361
 8.00866651

.08032570
 .07374504
 .07301725
 .07614234
 .08912029
 .10595112
 .12863482
 .15717139
 .18952785
 .22367122
 .25960150
 .29731868
 .33682276
 .37811375
 .42119165
 .46605645
 .50896897
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 .60355764
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 -.00365422
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 .00805151
 .01390439
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 .03146300
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 .03503682
 .03682372
 .03861063
 .04039753
 .04218444
 .04397135
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 .02299233

1.9.0

FR	2.00	37.00000000	8.62277174	.62370423	.01730085
FR	2.00	38.00000000	9.25417782	.63815935	.01160937
FR	2.00	39.00000000	9.89719329	.64692299	.00591789
FR	2.00	40.00000000	10.54612665	.64999514	.00022641
PN UP	6000.00000000				
GO TO	16.00000000				
	4.20687052				
	.82954215				
	-.29917699				
	.49583100				
	-.37592884				
	-.49514040				
IDENT. Z					
FR	3.00	16.00000000	4.20687052	.10369276	2ND DER.
PN DOWN	5000.00000000				-.00934928
FR	3.00	17.00000000	4.30685706	.09724874	-.00353876
FR	3.00	18.00000000	4.40330485	.09661524	.00227175
FR	3.00	19.00000000	4.50202439	.10179226	.00808227
FR	3.00	20.00000000	4.60882622	.11277980	.01389279
FR	3.00	21.00000000	4.72952084	.12957785	.01970331
FR	3.00	22.00000000	4.86991877	.15218643	.02551383
FR	3.00	23.00000000	5.03583055	.18060553	.03132435
FR	3.00	24.00000000	5.23306668	.21483514	.03713487
FR	3.00	25.00000000	5.46670344	.25267257	.03853997
FR	3.00	27.00000000	6.05100202	.33256273	.04135018
FR	3.00	28.00000000	6.40447403	.37461547	.04275528
FR	3.00	29.00000000	6.80070134	.41807331	.04416039
FR	3.00	30.00000000	7.24108903	.46293626	.04556549
FR	3.00	31.00000000	7.72704222	.50920430	.04697059
FR	3.00	32.00000000	8.25996602	.55687745	.04837570
FR	3.00	33.00000000	8.84029844	.60305450	.04397837
FR	3.00	34.00000000	9.46460924	.64483421	.03958105
FR	3.00	35.00000000	10.12850110	.68221661	.03518373
FR	3.00	36.00000000	10.82757669	.71520168	.03078641
FR	3.00	37.00000000	11.55743870	.74378943	.02638908
FR	3.00	38.00000000	12.31368979	.76797985	.02199176
FR	3.00	39.00000000	13.09193264	.78777296	.01759444
FR	3.00	40.00000000	13.88776994	.80316874	.01319711
PN UP	6000.00000000				
GO TO	16.00000000				
FR	3.00	26.00000000	13.88776994	.29191510	.03994508
			5.73888019		

B-34

DLC 26 ROW PROFILE 7 X 5 WATERLINE OFFSETS

INENT.	X	Y	1ST DER.	2ND DER.
WL 16.00	-13733000	0.00000000	0.00000000	0.00000000
PN DOWN 5000.00000000				
WL 16.00	.28733000	.17849315	1.35621694	1.25689116
WL 16.00	-43733000	.40745055	1.44832611	.11882215
WL 16.00	.58733000	.62798552	1.41873430	-.07075341
WL 16.00	.73733000	.84046038	1.41745719	.03367838
WL 16.00	.88733000	1.05348353	1.42302280	.04052980
WL 16.00	1.03733000	1.26741861	1.42961613	.04738123
WL 16.00	1.18733000	1.48241976	1.43723717	.05423265
WL 16.00	1.33733000	1.69864115	1.44588593	.06108407
WL 16.00	1.48733000	1.91623692	1.45556239	.06793549
WL 16.00	1.63733000	2.13536125	1.46626657	.07478691
WL 16.00	1.78733000	2.35616828	1.47799847	.08163833
WL 16.00	1.93733000	2.57881218	1.49075807	.08848975
WL 16.00	2.00000000	2.67241364	1.49639343	.09135228
WL 16.00	2.08733000	2.80343695	1.50419704	.08736338
WL 16.00	2.23733000	3.03002366	1.51678770	.08051196
WL 16.00	2.38733000	3.25842188	1.52835063	.07366054
WL 16.00	2.53733000	3.48847746	1.53888586	.06680911
WL 16.00	2.68733000	3.72003625	1.54839337	.05995769
WL 16.00	2.83733000	3.95294409	1.55687317	.05310627
WL 16.00	2.98733000	4.18704682	1.56432525	.04625485
WL 16.00	3.13733000	4.42219028	1.57074962	.03940343
WL 16.00	3.28733000	4.65822032	1.57614628	.03255201
WL 16.00	3.43733000	4.89498278	1.58051523	.02570059
WL 16.00	3.58733000	5.13232350	1.58385646	.01884917
WL 16.00	3.73733000	5.37008833	1.58616998	.01199775
WL 16.00	3.88733000	5.60812311	1.58745579	.00514633
WL 16.00	4.00000000	5.78700354	1.58774571	0.00000000
PN UP 6000.00000000				
GO TO	0.00000000	5.78700354		
	.11083364			
	1.37973560			
	0.00000000			

01408708
02156538

IDENT. X

WL 20.00 05867000
PN DOWN 5000.00000000
WL 20.00 09133000
WL 20.00 24133000
WL 20.00 39133000
WL 20.00 54133000
WL 20.00 69133000
WL 20.00 84133000
WL 20.00 99133000
WL 20.00 114133000
WL 20.00 129133000
WL 20.00 144133000
WL 20.00 159133000
WL 20.00 174133000
WL 20.00 189133000
WL 20.00 2000000000
WL 20.00 204133000
WL 20.00 219133000
WL 20.00 234133000
WL 20.00 249133000
WL 20.00 264133000
WL 20.00 279133000
WL 20.00 294133000
WL 20.00 309133000
WL 20.00 324133000
WL 20.00 339133000
WL 20.00 354133000
WL 20.00 369133000
WL 20.00 384133000
WL 20.00 399133000
WL 20.00 4000000000
PN UP 6000.00000000
GO TO 0.00000000

33295366
146290751
0.00000000
02045562
04091125

1ST DER.
0.00000000
1.353333122
1.42630062
1.39226567
1.39211975
1.39993381
1.40964963
1.42126720
1.43478653
1.45020762
1.46753046
1.48675505
1.50788140
1.53090951
1.54878056
1.55572886
1.58030265
1.60386687
1.62642151
1.64796659
1.66850209
1.68802802
1.70654439
1.72405118
1.74054840
1.75603605
1.77051412
1.78398263
1.79644157
1.79713083

2ND DER.
0.00000000
1.12847537
0.08559769
0.06973164
0.04575455
0.05843292
0.07111129
0.08378967
0.09646804
0.10914641
0.12182478
0.13450315
0.14718153
0.15985990
0.16904496
0.16719049
0.16046001
0.15372954
0.14699907
0.14026859
0.13353812
0.12680764
0.12007717
0.11334670
0.10661622
0.09988575
0.09315528
0.08642480
0.07969433
0.07930531

Y
0.00000000
0.20590749
0.43432158
0.65139250
0.85996055
1.06934080
1.28003578
1.49233077
1.70651103
1.92286182
2.14166841
2.36321605
2.58779001
2.81567556
2.98300148
3.04715643
3.28237142
3.52119675
3.76348100
4.00907273
4.25782050
4.50957288
4.76417843
5.02148572
5.28134330
5.54359976
5.80810364
6.07470352
6.34324795
6.35882609
6.35882609

IDENT.	X	Y	1ST DER.	2ND DER.
WL 24.00-	.25467000	0.00000000	0.00000000	0.00000000
PN DOWN 5000	.00000000			
WL 24.00-	.10467000	.15631356	1.38892585	1.37971448
WL 24.00	.04533000	.39056295	1.49789454	.13807856
WL 24.00	.19533000	.61864947	1.47095299	-.07068761
WL 24.00	.34533000	.83898190	1.47022568	.04238363
WL 24.00	.49533000	1.06006161	1.47796398	.06079369
WL 24.00	.64533000	1.28250917	1.48846378	.07920375
WL 24.00	.79533000	1.50673882	1.50172510	.09761380
WL 24.00	.94533000	1.73316478	1.51774793	.11602386
WL 24.00	1.09533000	1.96220127	1.53653226	.13443392
WL 24.00	1.24533000	2.19426253	1.55807810	.15284398
WL 24.00	1.39533000	2.42976278	1.58238546	.17125404
WL 24.00	1.54533000	2.66911625	1.60945432	.18966409
WL 24.00	1.69533000	2.91273715	1.63928469	.20807415
WL 24.00	1.84533000	3.16103973	1.67187656	.22648421
WL 24.00	1.99533000	3.41443820	1.70722995	.24489427
WL 24.00	2.00000000	3.42241364	1.70837495	.24546744
WL 24.00	2.14533000	3.67322121	1.74275261	.22763053
WL 24.00	2.29533000	3.93712591	1.77551644	.20922047
WL 24.00	2.44533000	4.20573807	1.80551875	.19081040
WL 24.00	2.59533000	4.47864346	1.83275956	.17240033
WL 24.00	2.74533000	4.75542786	1.85723885	.15399027
WL 24.00	2.89533000	5.03567705	1.87895664	.13558020
WL 24.00	3.04533000	5.31897678	1.89791291	.11717013
WL 24.00	3.19533000	5.60491285	1.91410768	.09876007
WL 24.00	3.34533000	5.89307101	1.92754094	.08035000
WL 24.00	3.49533000	6.18303705	1.93821268	.06193993
WL 24.00	3.64533000	6.47439674	1.94612292	.04352986
WL 24.00	3.79533000	6.76673585	1.95127164	.02511980
WL 24.00	3.94533000	7.05964016	1.95365886	.00670973
WL 24.00	4.00000000	7.16645338	1.95384227	-.00000012
PN UP 6000	.00000000			
GO TO	0.00000000			
	.68419091			
	1.73767510			
	0.00000000			
	.02029031			
	-.04058064			

IDENT. 1ST DER. 2ND DER.

IDENT. X

WL	28.00-	.45067900	0.00000000	0.00000000	0.00000000
PN	DOWN 5000	.00000000			
WL	28.00-	.30067000		1.61990873	1.77416727
WL	28.00-	.15067000	.41309747	1.77175117	.18642552
WL	28.00-	.00067000	.68279892	1.74393054	-.10213816
WL	28.00	.14933000	.94374550	1.73903249	.01817971
WL	28.00	.29933000	1.20487338	1.74312905	.03644099
WL	28.00	.44933000	1.46682118	1.74996479	.05470227
WL	28.00	.59933000	1.72999978	1.75953973	.07296355
WL	28.00	.74933000	1.99482006	1.77185386	.09122483
WL	28.00	.89933000	2.26169289	1.78690718	.10948612
WL	28.00	1.04933000	2.53102917	1.80469969	.12774740
WL	28.00	1.19933000	2.80323976	1.82523140	.14600868
WL	28.00	1.34933000	3.07873555	1.84850230	.16426996
WL	28.00	1.49933000	3.35792741	1.87451239	.18253124
WL	28.00	1.64933000	3.64122623	1.90326167	.20079252
WL	28.00	1.79933000	3.92904288	1.93475015	.21905380
WL	28.00	1.94933000	4.22178824	1.96897782	.23731508
WL	28.00	2.00000000	4.32186363	1.98115885	.24348375
WL	28.00	2.09933000	4.51983341	2.00474351	.23139111
WL	28.00	2.24933000	4.82307961	2.03808258	.21312982
WL	28.00	2.39933000	5.13112123	2.06868246	.19486852
WL	28.00	2.54933000	5.44354739	2.09654314	.17660722
WL	28.00	2.69933000	5.75994721	2.12166463	.15834593
WL	28.00	2.84933000	6.07990982	2.14404692	.14008463
WL	28.00	2.99933000	6.40302433	2.16369002	.12182333
WL	28.00	3.14933000	6.72887987	2.18059392	.10356204
WL	28.00	3.29933000	7.05706555	2.19475863	.08530074
WL	28.00	3.44933000	7.38717050	2.20618415	.06703944
WL	28.00	3.59933000	7.71878384	2.21487047	.04877814
WL	28.00	3.74933000	8.05149468	2.22081759	.03051685
WL	28.00	3.89933000	8.38489216	2.22402552	.01225555
WL	28.00	4.00000000	8.60882621	2.22464239	-.00000021
PN	UP 6000	.00000000			
GO	10	0.00000000	8.60882621		
		1.31824365			
		2.21104705			
		0.00000000			
		.01234325			
		-.02468653			

IDENT. X

Y

1ST DER.

2ND DER.

WL 32.00-	.64667000	0.00000000	0.00000000	0.00000000
PN DOWN 5000.00000000				
WL 32.00-	.49667000	2.07180071	2.07180071	2.23071720
WL 32.00-	.34667000	2.25935956	2.25935956	2.23433280
WL 32.00-	.19667000	2.22058051	2.22058051	2.14723676
WL 32.00-	.04667000	2.21112770	2.21112770	2.00345635
WL 32.00	.10333000	2.21144241	2.21144241	2.00765256
WL 32.00	.25333000	2.21342347	2.21342347	2.01876149
WL 32.00	.40333000	2.21707086	2.21707086	2.02987041
WL 32.00	.55333000	2.22238459	2.22238459	2.04097934
WL 32.00	.70333000	2.22936467	2.22936467	2.05208826
WL 32.00	.85333000	2.23801108	2.23801108	2.06319719
WL 32.00	1.00333000	2.24832382	2.24832382	2.07430611
WL 32.00	1.15333000	2.26030291	2.26030291	2.08541504
WL 32.00	1.30333000	2.27394834	2.27394834	2.09652396
WL 32.00	1.45333000	2.28926010	2.28926010	2.10763289
WL 32.00	1.60333000	2.30623820	2.30623820	2.11874181
WL 32.00	1.75333000	2.32488265	2.32488265	2.12985074
WL 32.00	1.90333000	2.34519343	2.34519343	2.14095966
WL 32.00	2.00000000	2.35916605	2.35916605	2.14811900
WL 32.00	2.05333000	2.36695992	2.36695992	2.14416939
WL 32.00	2.20333000	2.38775215	2.38775215	2.13306044
WL 32.00	2.35333000	2.40687805	2.40687805	2.12195149
WL 32.00	2.50333000	2.42433760	2.42433760	2.11084254
WL 32.00	2.65333000	2.44013081	2.44013081	2.09973358
WL 32.00	2.80333000	2.45425768	2.45425768	2.08862463
WL 32.00	2.95333000	2.46671820	2.46671820	2.07751568
WL 32.00	3.10333000	2.47751238	2.47751238	2.06640673
WL 32.00	3.25333000	2.48664022	2.48664022	2.05529778
WL 32.00	3.40333000	2.49410172	2.49410172	2.04418882
WL 32.00	3.55333000	2.49989687	2.49989687	2.03307987
WL 32.00	3.70333000	2.50402568	2.50402568	2.02197092
WL 32.00	3.85333000	2.50648815	2.50648815	2.01086197
WL 32.00	4.00000000	2.50728469	2.50728469	2.00000036
PN UP 6000.00000000				
GO TO 0.00000000				
2.33398630				
2.83734006				
0.00000000				
.00000001				
-.01843006				

IDENT.	X	Y	1ST DER.	2ND DER.
WL 36.00--	.84267000	0.00000000	0.00000000	0.00000000
PN DOWN 5000	.00000000			
WL 36.00--	.69267000	.52047778	2.70562329	2.63983062
WL 36.00--	.54267000	.77692813	2.90827910	.23943323
WL 36.00--	.39267000	1.21944122	2.84860059	-.18759211
WL 36.00--	.24267000	1.64544899	2.83734006	-.00000001
WL 36.00--	.09267000	2.07105000	2.83734006	0.00000000
WL 36.00	.05733000	2.49665101	2.83734006	0.00000000
WL 36.00	.20733000	2.92225202	2.83734006	.00000001
WL 36.00	.35733000	3.34785303	2.83734006	.00000002
WL 36.00	.50733000	3.77345404	2.83734007	.00000003
WL 36.00	.65733000	4.19905505	2.83734007	.00000003
WL 36.00	.80733000	4.62465606	2.83734008	.00000004
WL 36.00	.95733000	5.05025707	2.83734009	.00000005
WL 36.00	1.10733000	5.47585809	2.83734010	.00000006
WL 36.00	1.25733000	5.90145910	2.83734011	.00000007
WL 36.00	1.40733000	6.32706012	2.83734012	.00000008
WL 36.00	1.55733000	6.75266114	2.83734013	.00000009
WL 36.00	1.70733000	7.17826216	2.83734015	.00000010
WL 36.00	1.85733000	7.60386318	2.83734016	.00000011
WL 36.00	2.00000000	8.00866651	2.83734018	.00000012
WL 36.00	2.00733000	8.02946420	2.83733721	-.00081043
WL 36.00	2.15733000	8.45499347	2.83597161	-.01739748
WL 36.00	2.30733000	8.88013129	2.83211796	-.03398453
WL 36.00	2.45733000	9.30450445	2.82577625	-.05057159
WL 36.00	2.60733000	9.72773976	2.81694649	-.06715864
WL 36.00	2.75733000	10.14946400	2.80562866	-.08374569
WL 36.00	2.90733000	10.56930396	2.79182278	-.10033275
WL 36.00	3.05733000	10.98688643	2.77552883	-.11691980
WL 36.00	3.20733000	11.40183821	2.75674683	-.13350685
WL 36.00	3.35733000	11.81378608	2.73547678	-.15009390
WL 36.00	3.50733000	12.2235684	2.71171866	-.16668096
WL 36.00	3.65733000	12.62717728	2.68547249	-.18326801
WL 36.00	3.80733000	13.02787418	2.65673826	-.19985506
WL 36.00	3.95733000	13.42407435	2.62551597	-.21644212
WL 36.00	4.00000000	13.53590665	2.61617971	-.22116058
PN UP 6000	.00000000			
GO TO 3.67370095	0.00000000			
	3.43621277			

IDENT.		X		Y	1ST DER.	2ND DER.
WL	40.00-	1.03667000	0.00000000	0.00000000	0.00000000	0.00000000
PN	DOWN 5000.00000000					
WL	40.00-	.88867000	.53902558	3.38924194	2.70757343	
WL	40.00-	.73867000	1.11071425	3.55115066	.13491740	
WL	40.00-	.58867000	1.65035508	3.45158707	-.26196210	
WL	40.00-	.43867000	2.16633749	3.43621278	-.00000005	
WL	40.00-	.28867000	2.68176940	3.43621277	-.00000003	
WL	40.00-	.13867000	3.19720132	3.43621277	-.00000001	
WL	40.00	.01133000	3.71263324	3.43621277	0.00000000	
WL	40.00	.16133000	4.22806515	3.43621277	.00000001	
WL	40.00	.31133000	4.74349707	3.43621277	.00000003	
WL	40.00	.46133000	5.25892898	3.43621278	.00000005	
WL	40.00	.61133000	5.77436090	3.43621279	.00000007	
WL	40.00	.76133000	6.28979282	3.43621280	.00000009	
WL	40.00	.91133000	6.80522474	3.43621281	.00000010	
WL	40.00	1.06133000	7.32065667	3.43621283	.00000012	
WL	40.00	1.21133000	7.83608860	3.43621285	.00000014	
WL	40.00	1.36133000	8.35152053	3.43621288	.00000016	
WL	40.00	1.51133000	8.86695246	3.43621290	.00000018	
WL	40.00	1.66133000	9.38238440	3.43621293	.00000019	
WL	40.00	1.81133000	9.89781634	3.43621296	.00000021	
WL	40.00	1.96133000	10.41324829	3.43621300	.00000023	
WL	40.00	2.00000000	10.54612665	3.43621301	.00000024	
WL	40.00	2.11133000	10.92854975	3.43269663	-.06317052	
WL	40.00	2.26133000	11.42424440	3.41683759	-.14828337	
WL	40.00	2.41133000	11.95296268	3.38821162	-.23339623	
WL	40.00	2.56133000	12.45824954	3.34681872	-.31850908	
WL	40.00	2.71133000	12.95636995	3.29265889	-.40362194	
WL	40.00	2.86133000	13.44540886	3.22573213	-.48873460	
WL	40.00	3.01133000	13.92345125	3.14603845	-.57384765	
WL	40.00	3.16133000	14.38858205	3.05357784	-.65896051	
WL	40.00	3.31133000	14.83888625	2.94835030	-.74407336	
WL	40.00	3.46133000	15.27244880	2.83035583	-.82918622	
WL	40.00	3.61133000	15.68735465	2.69959443	-.91429908	
WL	40.00	3.76133000	16.08168878	2.55606610	-.99941193	
WL	40.00	3.91133000	16.45353614	2.39977085	-1.08452479	
WL	40.00	4.00000000	16.66199443	2.30137541	-1.13483784	

1.5.0

PN UP
GO TO

600C.000000000
0.000000000

16.66199443

13.42

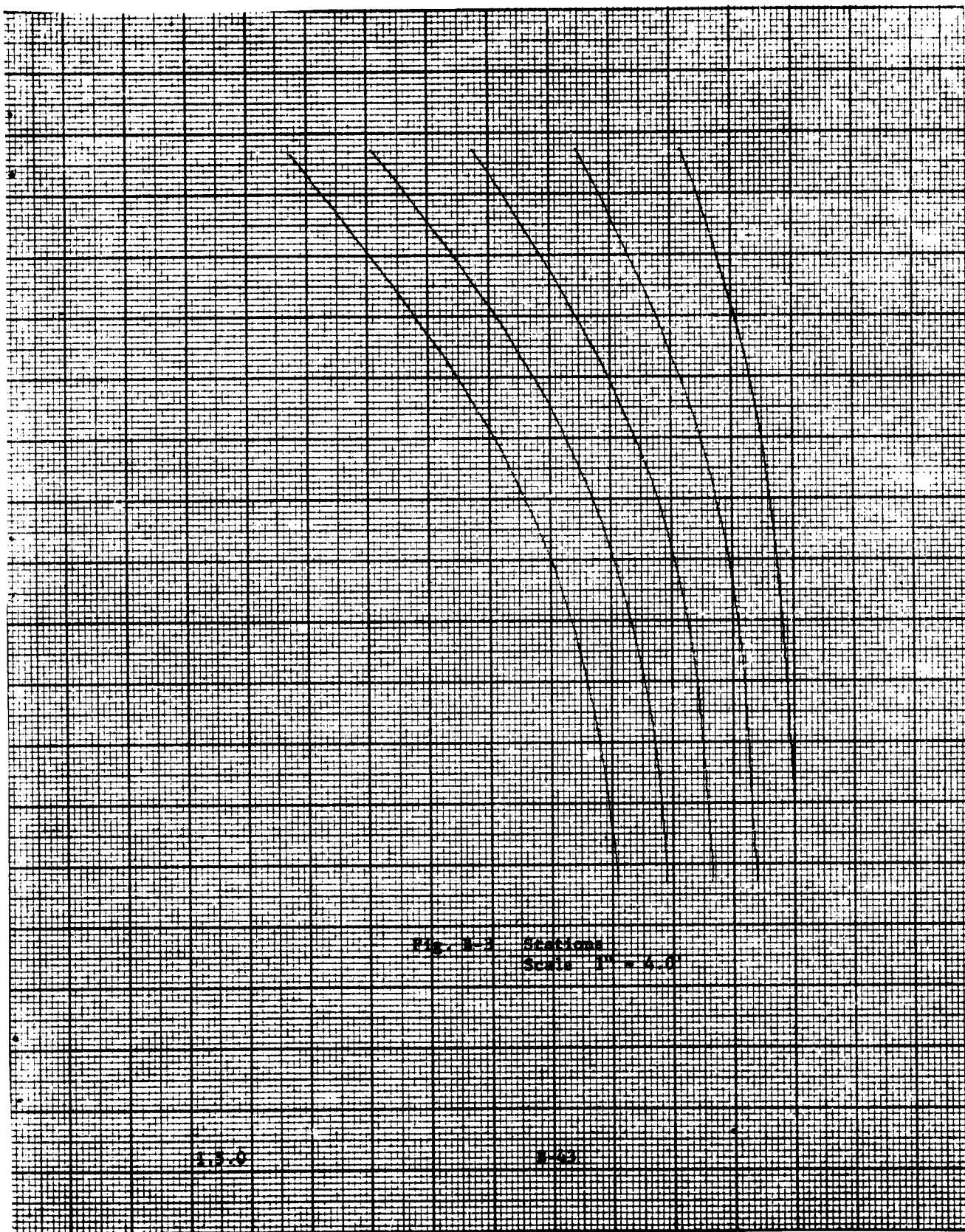


Fig. 8-2 Stations
Scale 1" = 4.0'

10.4 - 1.7 9.93

5.2 - 2

Scale 1" = 6.125'

Fig. 8-4. Waterlines

1.5.0

2.20

Appendix C

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Appendix C

DLG-26 HULL SURFACES

The surfaces contained in this Appendix are a set of surfaces which extend from the baseline to above the sheer line on the DLG-26 class frigate. These surfaces result from an attempt to more completely fair a ship's hull in order to determine the capabilities and problems associated with the fairing method. The surfaces presented cover representative sections of the ship's hull. The extent of the hull which each covers is shown in the figure.

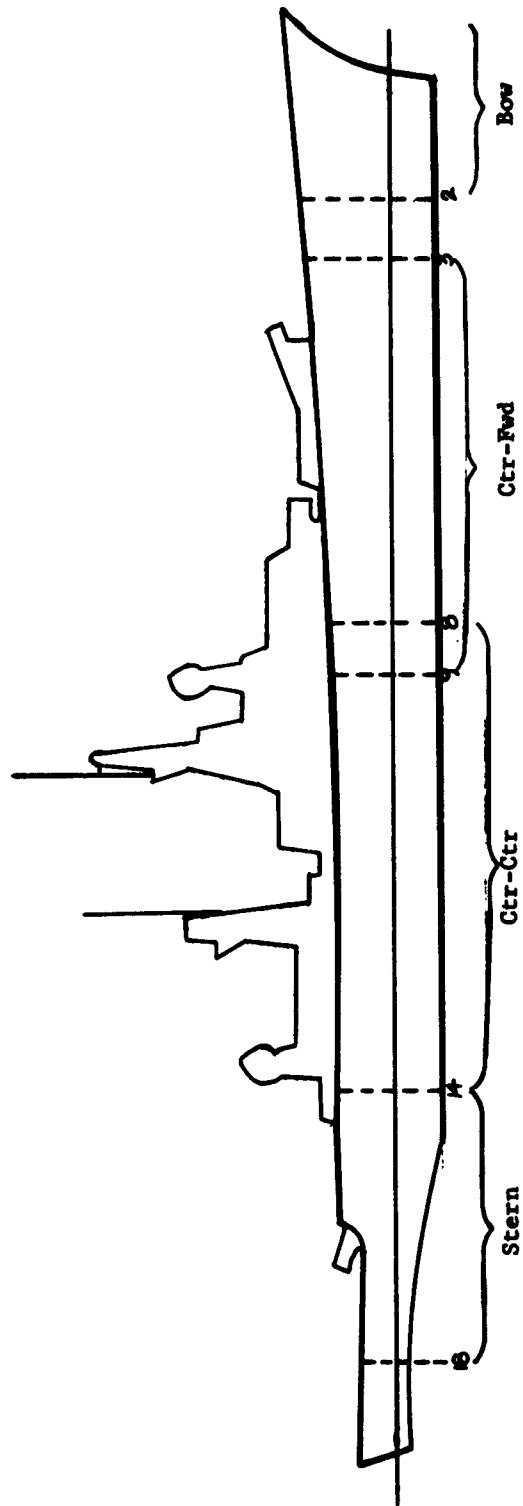


Fig. C-1 Extent of Faired Surfaces, DLG-26

UPPER BOW SECTION OF DLG-26

Project:

To fair the extreme forward section of the DLG-26 including the end profile above Waterline 16, for the purpose of testing the ability of the end profile fairing formulation.

Data:

The data was the preliminary offsets of DLG-26 on Stations 0, 1/2, 1, 1-1/2, 2, at Waterlines 16, 20, 24, 28, 32, 36, and 40. The surface was re-faired slightly to eliminate the knuckle. In addition the offsets which describe the bow profile in this area were used.

Procedure:

The profile of the bow above the sixteen-foot waterline was determined to be a straight line, and its equation was found. The equation and the preliminary offsets were entered into SMOG-2. This program punched the LP matrix in the end profile formulation using the fit and dual tableau on the IBM-1620. The surface was faired on the IBM-7090 using LP-90 in approximately fifteen minutes. The results were then solved for on the 1620 using GOBACK-2 and plotted as shown.

Results:

The faired surface went exactly through the profile equation. The surface is completely fair but shows a slight hook at the extreme ends of the waterlines. This may require some adjustment of the profile turn.

* BOW PROFILE DLG 11X5			
0	-1	.2	3.0
11	5	0.0	.0001
			3. .33333333
.8562			
-.26795			
0.0			
-.0786			
.1531			
-.0704			
-.0041			
0.0			
0.0			
0.0			
0.0			
0.0			
0.0			
0.0			
.0000			
.0000		.000000	
1.0000		4.062500	
2.0000		7.500000	
3.0000		4.374999	
4.0000		1.906249	
.5000			
.0000		.000000	
1.0000		1.052083	
2.0000		3.302083	
3.0000		2.958333	
4.0000		3.593749	
1.0000			
.0000		.000000	
1.0000		.916666	
2.0000		2.354166	
3.0000		3.437499	
4.0000		4.729166	
1.5000			
.0000		.000000	
1.0000		1.041666	
2.0000		2.458333	
3.0000		3.874999	
4.0000		5.333333	
2.0			
.0000		.000000	
1.0000		1.239583	
2.0000		2.697916	
3.0000		4.197916	
4.0000		5.812500	
2.5			
.0000		.078000	

Profile equations

Preliminary offsets

	1.0000	1.479166		
	2.0000	2.979166		
	3.0000	4.583333		
	4.0000	6.333333		
3.0				
	.0000	.343749		
	1.0000	1.791666		
	2.0000	3.447916		
	3.0000	5.250000		
	4.0000	7.166666		
3.5				
	.0000	.708333		
	1.0000	2.416666		
	2.0000	4.322916		
	3.0000	6.416666		
	4.0000	8.583333		
4.0				
	.0000	1.343749		
	1.0000	3.531250		
	2.0000	5.864583		
	3.0000	8.250000		
	4.0000	10.750000		
4.5				
	.0000	2.312500		
	1.0000	5.145833		
	2.0000	8.000000		
	3.0000	10.802083		
	4.0000	13.510416		
5.0				
	.0000	3.697916		
	1.0000	7.135416		
	2.0000	10.52063		
	3.0000	13.9		
	4.0000	16.68749		
1.0	1.0		0.0	0.0

80W DLG 26 STATIONS

-7.16765334
5.17799440
2.89710319
-2.33844915
3.81770188
-1.54632108
.34638152
-.44640127

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FR 0.00	19.80224609	.02116141	.04221143	.01051504
FR 0.00	20.80224609	.07578305	.05570597	.00785420
FR 0.00	21.80224609	.14068689	.06421512	.00608525
FR 0.00	22.80224609	.21041517	.06974812	.00470939
FR 0.00	23.80224609	.28276716	.07374962	.00383426
FR 0.00	24.00000000	.29742548	.07449322	.00369715
FR 0.00	25.00000000	.37431281	.07982697	.00697035
FR 0.00	26.00000000	.45817050	.08843393	.01024355
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FR 0.00	31.00000000	1.09657630	.18056672	.02660956
FR 0.00	32.00000000	1.29099334	.20881288	.02988276
FR 0.00	33.00000000	1.51442126	.23771661	.02792469
FR 0.00	34.00000000	1.76577388	.26466228	.02596663
FR 0.00	35.00000000	2.04309313	.28964988	.02400857
FR 0.00	36.00000000	2.34442096	.31267942	.02205050
FR 0.00	37.00000000	2.66779929	.33575089	.02009244
FR 0.00	38.00000000	3.01127007	.35286431	.01813438
FR 0.00	39.00000000	3.37287523	.37001966	.01617631
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	10.77801340			
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1.5.0

C-6

1.5.0

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C-7

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 FR 10.20 23.00000000

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FR	10.20	36.00000000	7.96103520	.60887479	.02894616
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FR	15.30	7.00000000	3.22753539	.15745848	.01130857
FR	15.30	8.00000000	3.38474335	.15105262	-.02412029
FR	15.30	9.00000000	3.52436834	.12882987	-.02032519
FR	15.30	10.00000000	3.64366813	.11040222	-.01653009
FR	15.30	11.00000000	3.74643783	.09576968	-.01273499

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1.6.0

FR 15.30	12.00000000	5.83647253	.08493223	-.00893989
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FR 15.30	16.00000000	4.14516336	.07953344	.00624050
FR 15.30	17.00000000	4.22835296	.08738167	.00945596
FR 15.30	18.00000000	4.32099854	.09844537	.01267142
FR 15.30	19.00000000	4.42631553	.11272453	.01588688
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FR 15.30	36.00000000	10.76345309	.70194881	.03702863
FR 15.30	37.00000000	11.48360018	.73802931	.03513236
FR 15.30	38.00000000	12.23887963	.77221353	.03323608
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 -.55744084
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IDENT. Z

FR 20.40 0.00000000

Y 1.6549330

FIRST DER.
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-.06253272

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FR	20.40	4.00000000	3.64648661	.34754190	-.04426345
FR	20.40	5.00000000	3.97265800	.30556210	-.03969613
FR	20.40	6.00000000	4.25413327	.26814963	-.03512881
FR	20.40	7.00000000	4.51047971	.23530447	-.03056149
FR	20.40	8.00000000	4.73126466	.20702663	-.02599417
FR	20.40	9.00000000	4.92583575	.18265709	-.02274490
FR	20.40	10.00000000	5.09766193	.16153682	-.01949563
FR	20.40	11.00000000	5.24992448	.14366581	-.01624636
FR	20.40	12.00000000	5.38607666	.12904409	-.01299709
FR	20.40	13.00000000	5.50916375	.11767163	-.00974782
FR	20.40	14.00000000	5.62250302	.10954844	-.00649855
FR	20.40	15.00000000	5.72934374	.10467453	-.00324927
FR	20.40	16.00000000	5.83293518	.10304989	0.00000000
FR	20.40	17.00000000	5.93693195	.10589054	.00568132
FR	20.40	18.00000000	6.04661004	.11441253	.01136264
FR	20.40	19.00000000	6.16765079	.12861584	.01704397
FR	20.40	20.00000000	6.30573550	.14850048	.02272530
FR	20.40	21.00000000	6.46654552	.17406644	.02840663
FR	20.40	22.00000000	6.65576217	.20531374	.03408795
FR	20.40	23.00000000	6.87906678	.24224236	.03976928
FR	20.40	24.00000000	7.14214068	.28485231	.04545061
FR	20.40	25.00000000	7.44957643	.32987733	.04459943
FR	20.40	26.00000000	7.80161161	.37405117	.04374824
FR	20.40	27.00000000	8.19739504	.41737382	.04289706
FR	20.40	28.00000000	8.63607554	.45984530	.04204588
FR	20.40	29.00000000	9.11680192	.50146559	.04119470
FR	20.40	30.00000000	9.63872300	.54223470	.04034351
FR	20.40	31.00000000	10.20098760	.58215263	.03949233
FR	20.40	32.00000000	10.80274454	.62121937	.03864115
FR	20.40	33.00000000	11.44275952	.65828561	.03549132
FR	20.40	34.00000000	12.11826582	.69220202	.03234150
FR	20.40	35.00000000	12.82611363	.72296861	.02919167
FR	20.40	36.00000000	13.56315312	.75058537	.02604184
FR	20.40	37.00000000	14.32623445	.77505231	.02289202
FR	20.40	38.00000000	15.11220780	.79636942	.01974219
FR	20.40	39.00000000	15.91792335	.81453670	.01659236
FR	20.40	40.00000000	16.74023127	.82955416	.01344254

1.5.0

PEN UP
GO TO

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0.000000000

16.74023127

C-12

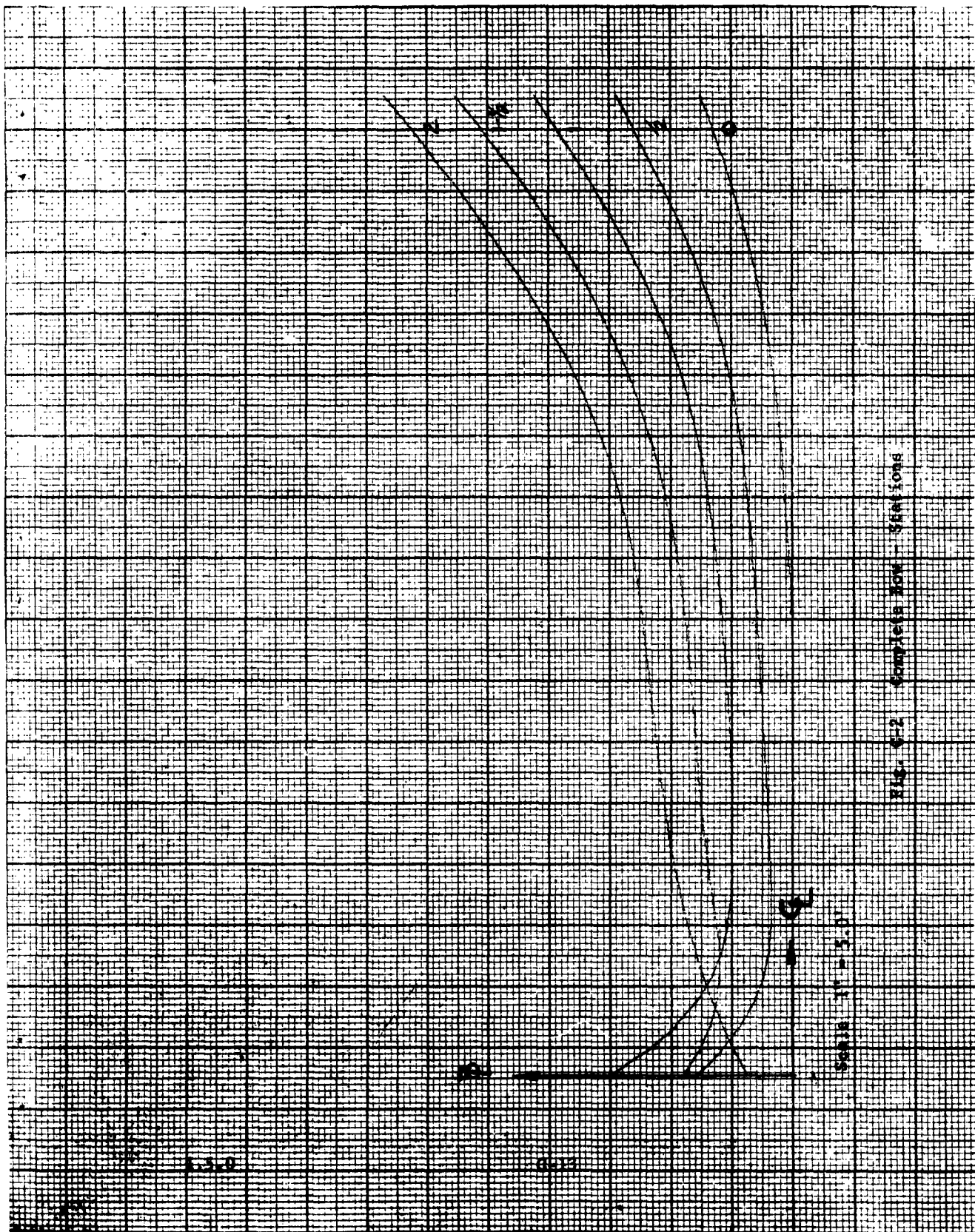


Fig. 6-2 Complete Row - Stations

CENTER - FORWARD SURFACE OF DLG-26

Project:

To fair a section of the DLG-26, extending from Station 3 to Station 9, for the purpose of testing the method on surfaces containing large slopes.

Data:

The data consisted of preliminary offsets for DLG-26 on Stations 4 through 10 at Waterlines from the baseline to the 36 at four-foot intervals.

Procedure:

The data was smoothed and then used with SMOG-1 to punch the LP matrix for the λ - dual formulation double splined in the X direction only. The surface was faired on the IBM-7090 in fifty minutes. The results were then calculated using GOBACK-1.

Results:

The surface is fair everywhere except in the area influenced by the first cubic interval above the baseline. Because no sign on the second derivative in the vertical direction was required on the baseline, a line of inflection is apparent in part of the surface. This is caused by the high slopes at the baseline and points out a need for curvature control at the first point.

* DLG 26 CENTER SECT 11X7 DUAL NO Z 12-20

0 0
11 7 0. 0.0001
7 11

0.
25.5000 1.000000
51.0000 1.000000
76.5000 1.000000
102.0000 1.000000
127.5000 1.000000
153.0000 1.000000
178.5000 1.000000

2.0000
25.5000 4.031250
51.0000 5.562500
76.5000 7.114583
102.0000 8.833333
127.5000 10.666667
153.0000 12.427083
178.5000 13.739583

4.0000
25.5000 5.666667
51.0000 7.833333
76.5000 10.031250
102.0000 12.354167
127.5000 14.645833
153.0000 16.593750
178.5000 18.020833

8.0000
25.5000 7.500000
51.0000 10.322917
76.5000 13.302083
102.0000 16.250000
127.5000 18.875000
153.0000 21.000000
178.5000 22.562500

12.0000
25.5000 8.427083
51.0000 11.781250
76.5000 15.166667
102.0000 18.343750
127.5000 21.072917
153.0000 23.239583
178.5000 24.770833

16.0000
25.5000 9.250000
51.0000 12.916667

76.5000	16.454167		
102.0000	19.666667		
127.5000	22.291667		
153.0000	24.364583		
178.5000	25.770833		
20.0000			
25.5000	10.125000		
51.0000	14.114583		
76.5000	17.697917		
102.0000	20.708333		
127.5000	23.104167		
153.0000	24.885417		
178.5000	26.114583		
24.0000			
25.5000	11.375000		
51.0000	15.468750		
76.5000	18.937500		
102.0000	21.635417		
127.5000	23.718750		
153.0000	25.208333		
178.5000	26.208333		
28.0000			
25.5000	13.093750		
51.0000	17.000000		
76.5000	20.229167		
102.0000	22.520833		
127.5000	24.229167		
153.0000	25.416667		
178.5000	26.229167		
32.0000			
25.5000	15.260417		
51.0000	18.916667		
76.5000	21.625000		
102.0000	23.354167		
127.5000	24.572917		
153.0000	25.510417		
178.5000	26.208333		
36.00000			
25.5	18.10416		
51.000	21.18749		
76.5	23.03125		
102.0	24.16666		
127.5	25.01041		
153.0	25.69791		
178.5	26.22916		
51.0	6.0	25.50	0.0

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DLG 26 CENTER SECT 11X7 STATIONS

IDENT.	FR	3.00	Z	Y	FIRST DER.	SECOND DER.	
	FR	3.00	.00000000	1.00000000	2.89251380	-2.04860510	453
	PEN	DOWN	5000.00000000				454
	FR	3.00	.50000000	2.21152110	1.99625030	-1.53644870	455
	FR	3.00	.99999996	3.03892990	1.35606500	-1.02429230	456
	FR	3.00	1.49999990	3.61026580	.97195803	-.51213600	457
	FR	3.00	1.99999990	4.05356750	.84392933	.00002038	458
	FR	3.00	2.00000000	4.05356770	.84392916	.00002047	459
	FR	3.00	2.49999990	4.47402020	.83485125	-.03633300	460
	FR	3.00	2.99999990	4.88538950	.80759625	-.07268627	461
	FR	3.00	3.49999990	5.27858760	.76216500	-.10903972	462
	FR	3.00	3.99999980	5.64452430	.69855666	-.14539316	463
	FR	3.00	4.00000000	5.64452410	.69855650	-.14539302	464
	FR	3.00	4.49999980	5.97610890	.62874585	-.13385054	465
	FR	3.00	4.99999980	6.27423230	.56470608	-.12230779	466
	FR	3.00	5.49999980	6.54177710	.50643788	-.11076529	467
	FR	3.00	5.99999980	6.78162990	.45394256	-.09922252	468
	FR	3.00	6.49999920	6.99667480	.40721560	-.08768005	469
	FR	3.00	6.99999900	7.18980670	.36626100	-.07613755	470
	FR	3.00	7.49999980	7.36389970	.33107991	-.06459480	471
	FR	3.00	7.99999860	7.52184690	.30166905	-.05305202	472
	FR	3.00	7.99999980	7.52184390	.30166618	-.05305191	473
	FR	3.00	8.49999840	7.66632460	.27679795	-.04642045	474
	FR	3.00	8.99999820	7.79920360	.25524428	-.03978917	475
	FR	3.00	9.49999800	7.92211320	.23700636	-.03315761	476
	FR	3.00	9.99999780	8.03675050	.22208926	-.02652603	477
	FR	3.00	10.49999980	8.14474690	.21048293	-.01989475	478

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FR	3.00	10.99999700	8.24778640	.20219400	-.01326347	493
FR	3.00	11.49999700	8.34749520	.19721913	-.00663161	494
FR	3.00	11.99999700	8.44553960	.19556001	-.00000033	495
FR	3.00	12.00000000	8.44555900	.19556240	-.00000036	496
FR	3.00	12.49999700	8.54333030	.19556433	.00000766	497
FR	3.00	12.99999700	8.64110260	.19557105	.00001620	498
FR	3.00	13.49999600	8.73890880	.19558200	.00002415	499
FR	3.00	13.99999600	8.83667660	.19559186	.00003211	500
FR	3.00	14.49999600	8.93449860	.19561598	.00004065	501
FR	3.00	14.99999600	9.03230420	.19563750	.00004860	502
FR	3.00	15.49999600	9.13012450	.19565975	.00005656	503
FR	3.00	15.99999500	9.22796890	.19569278	.00006482	504
FR	3.00	16.00000000	9.22798540	.19569371	.00006483	505
FR	3.00	16.49999500	9.32599730	.19680213	.00437549	506
FR	3.00	16.99999500	9.42512500	.20007030	.00868592	507
FR	3.00	17.49999500	9.52642360	.20549211	.01299663	508
FR	3.00	17.99999500	9.63094210	.21306608	.01730737	509
FR	3.00	18.49999400	9.73990960	.22280018	.02161780	510
FR	3.00	18.99999400	9.85426400	.23468126	.02592851	511
FR	3.00	19.49999400	9.97494720	.24873786	.03023897	512
FR	3.00	19.99999400	10.10324900	.26493160	.03454968	513
FR	3.00	20.00000000	10.10321900	.26492295	.03454990	514
FR	3.00	20.49999400	10.24005100	.28171443	.03255615	515
FR	3.00	20.99999300	10.38475500	.29749375	.03056229	516
FR	3.00	21.49999300	10.53725400	.31226978	.02856896	517
FR	3.00	21.99999300	10.69683300	.32605896	.02657508	518
FR	3.00	22.49999300	10.86319000	.33884455	.02458123	519
FR	3.00	22.99999300	11.03549900	.35064336	.02258761	520
FR	3.00	23.49999200	11.21356700	.36142096	.02059401	521
FR	3.00	23.99999200	11.39688000	.37124713	.01860012	522
FR	3.00	24.00000000	11.39682400	.37122805	.01860013	523
FR	3.00	24.49999200	11.58477900	.38103006	.02051999	524
FR	3.00	24.99999200	11.77809400	.39176818	.02243991	525
FR	3.00	25.49999200	11.97666900	.40345661	.02435954	526
FR	3.00	25.99999100	12.18147800	.41610023	.02627946	527
FR	3.00	26.49999100	12.39290700	.42974755	.02819909	528
FR	3.00	26.99999100	12.61149100	.44433003	.03011898	529
FR	3.00	27.49999100	12.83732200	.45986613	.03204364	530
FR	3.00	27.99999100	13.07157200	.47635728	.03396131	531
FR	3.00	28.00000000	13.07129200	.47637406	.03395923	532
FR	3.00	28.49999000	13.31398900	.49373496	.03555271	533

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FR	3.00	28.99999000	13.56006100	.51188330	.03714134	534
FR	3.00	29.49999000	13.82598200	.53087071	.03873550	535
FR	3.00	29.99999000	14.09615900	.55064881	.04032411	536
FR	3.00	30.49999000	14.37673700	.57119768	.04191552	537
FR	3.00	30.99998900	14.66753200	.59256871	.04350415	538
FR	3.00	31.49998900	14.96442800	.61471236	.04509553	539
FR	3.00	31.99998900	15.26227900	.63765978	.04668692	540
FR	3.00	32.49998900	15.56223700	.66163513	.04828775	541
FR	3.00	32.99998900	15.86464000	.68654185	.04989206	542
FR	3.00	33.49998900	16.16912500	.71249996	.05150420	543
FR	3.00	33.99998900	16.47449200	.73945470	.02917918	544
FR	3.00	34.49998900	16.78052100	.76737031	.02336416	545
FR	5.00	34.99998900	16.99198900	.7958713	.01750913	546
FR	5.00	35.49998900	17.35250900	.72512673	.0167135	547
FR	5.00	35.99998900	17.71164900	.72951971	.00583634	548
FR	5.00	36.49998900	18.00130400	.73102258	.00009131	549
FR	5.00	36.99998900	18.23781300	.73102258	.00000200	550
PEN UP	5000.00000000		18.00201300			551
GO TO	1.00000000					552
	6.25372100					553
	45.92500600					554
	-72.43347000					555
	98.94140000					556
	-27.25251000					557
	1.26832000					558
	-1.17099304					559
	-54481860					560
	-33757908					561
	-13800668					562
	-16955630					563
	1.19755040					564
IDENT.						565
FR	4.00	.00000000	1.00000000	1.05979680	2.55141640	566
PEN DOWN	5000.00000000					567
FR	4.00	.50000000	1.80690290	2.06399000	1.54539600	568
FR	4.00	.99999990	3.00015480	2.60510280	.53937569	569
FR	4.00	1.49999990	4.32825080	2.62335560	.46664472	570
FR	4.00	1.99999990	5.53968540	2.13813810	-1.47266500	571
FR	4.00	2.00000000	5.53968550	2.13953810	-1.47266520	572
FR	4.00	2.49999990	6.44021070	1.40424690	-1.10449960	573

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FR	4.00	2.99999990	7.06461190	1.03403860	-.73633388	575
FR	4.00	3.49999990	7.50493000	.75791300	-.36816805	576
FR	4.00	3.99999980	7.85320670	.66587116	-.00000250	577
FR	4.00	4.00000000	7.85320620	.66587033	-.00000250	578
FR	4.00	4.49999980	8.18570980	.66328271	-.01034819	579
FR	4.00	4.99999980	8.51562660	.65552225	-.02069400	580
FR	4.00	5.49999980	8.84037090	.64258961	-.03103952	581
FR	4.00	5.99999980	9.15735400	.62448150	-.04138502	582
FR	4.00	6.49999920	9.46400000	.60120633	-.05173069	583
FR	4.00	6.99999900	9.75769700	.57275400	-.06207636	584
FR	4.00	7.49999980	10.03587600	.53912950	-.07242200	585
FR	4.00	7.99999860	10.29595800	.50033100	-.08276777	586
FR	4.00	7.99999980	10.29596000	.50033233	-.08276777	587
FR	4.00	8.49999840	10.53609100	.46083363	-.07522005	588
FR	4.00	8.99999820	10.75741000	.42511243	-.06767228	589
FR	4.00	9.49999800	10.96184700	.39316406	-.06012478	590
FR	4.00	9.99999780	11.15122100	.36498851	-.05257701	591
FR	4.00	10.49999800	11.32745300	.34058563	-.04502924	592
FR	4.00	10.99999700	11.49244200	.31995640	-.03748175	593
FR	4.00	11.49999700	11.64804400	.30310466	-.02993398	594
FR	4.00	11.99999700	11.79615300	.29002460	-.02238648	595
FR	4.00	12.00000000	11.79615800	.29002170	-.02238638	596
FR	4.00	12.49999700	11.93860300	.28012746	-.01721221	597
FR	4.00	12.99999700	12.07675300	.27279788	-.01203823	598
FR	4.00	13.49999600	12.21181100	.26808250	-.00686453	599
FR	4.00	13.99999600	12.34525400	.26593133	-.00169888	600
FR	4.00	14.49999600	12.47807300	.26638266	-.00347508	601
FR	4.00	14.99999600	12.61201700	.26941996	-.00864878	602
FR	4.00	15.49999600	12.74800400	.27502808	-.01381999	603
FR	4.00	15.99999500	12.88740600	.28322371	-.01899368	604
FR	4.00	16.00000000	12.88748100	.28321985	-.01899355	605
FR	4.00	16.49999500	13.03133600	.29213191	-.01659803	606
FR	4.00	16.99999500	13.17950700	.29984248	-.01420510	607
FR	4.00	17.49999500	13.33102800	.30634048	-.01181189	608
FR	4.00	17.99999500	13.48550500	.31165758	-.00941614	609
FR	4.00	18.49999400	13.64247700	.31576210	-.00702320	610
FR	4.00	18.99999400	13.80110300	.31868736	-.00462721	611
FR	4.00	19.49999400	13.96094800	.32038358	-.00223428	612
FR	4.00	19.99999400	14.12137300	.32091515	-.00016173	613
FR	4.00	20.00000000	14.12138700	.32091040	-.00016051	614
FR	4.00	20.49999400	14.28183800	.32140611	-.00213317	615

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FR	4.00	20.99999300	14.44297000	.32302863	.00442814	616
FR	4.00	21.49999300	14.60508800	.32583085	.00672002	617
FR	4.00	21.99999300	14.76906300	.32979778	.00901499	618
FR	4.00	22.49999300	14.93508400	.33484425	.01130718	619
FR	4.00	22.99999300	15.10427000	.34109558	.01360186	620
FR	4.00	23.49999200	15.27633100	.34846813	.01589680	621
FR	4.00	23.99999200	15.45257900	.35697056	.01818899	622
FR	4.00	24.00000000	15.45270800	.35696895	.01818863	623
FR	4.00	24.49999200	15.63344100	.36615115	.01855751	624
FR	4.00	24.99999200	15.81868500	.37551153	.01892349	625
FR	4.00	25.49999200	16.00899300	.38509681	.01929195	626
FR	4.00	25.99999100	16.20434000	.39483893	.01966072	627
FR	4.00	26.49999100	16.40390500	.40473741	.02002670	628
FR	4.00	26.99999100	16.60866700	.41485886	.02039519	629
FR	4.00	27.49999100	16.81890600	.42513746	.02076115	630
FR	4.00	27.99999100	17.03359600	.43563946	.02112991	631
FR	4.00	28.00000000	17.03414800	.43556086	.02113150	632
FR	4.00	28.49999000	17.25421900	.44570868	.01914349	633
FR	4.00	28.99999000	17.47996800	.45475776	.01715731	634
FR	4.00	29.49999000	17.70862200	.46285215	.01516804	635
FR	4.00	29.99999000	17.94247800	.46990908	.01317908	636
FR	4.00	30.49999000	18.17882400	.47607845	.01119289	637
FR	4.00	31.49998900	18.41775100	.48112686	.00920643	638
FR	4.00	31.99998900	18.65884900	.48522151	.00722022	639
FR	4.00	32.00000000	18.90260100	.48839525	.00523128	640
FR	4.00	32.49998900	18.90338600	.48836793	.00523146	641
FR	4.00	32.99998900	19.14779200	.49460461	.01987164	642
FR	4.00	32.99998900	19.39958600	.50827573	.03451544	643
FR	4.00	33.49998800	19.65771700	.52914018	.04915891	644
FR	4.00	33.99998800	19.92952900	.55734898	.06380270	645
FR	4.00	34.49998800	20.21619700	.59295196	.07844369	646
FR	4.00	34.99998800	20.52453000	.63581568	.09308444	647
FR	4.00	35.49998800	20.85280100	.68605705	.10772820	648
FR	4.00	35.99998700	21.21143900	.74357511	.12237200	649
FR	4.00	36.00000000	21.20957500	.74350213	.12237123	650
PEN UP		6000.00000000				651
GO TO		1.00000000	21.20957500			652
		36.06414000				653
		-79.14455000				654
		78.27756000				655

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-82.39828000	IDENT.	Z	Y	FIRST DER.	SECOND DER.	657
6.04407000	FR 5.00	.00000000	1.00000000	6.01069000	-4.39691940	658
-1.62188600	PEN DOWN 5000.00000000					659
-0.03267765	FR 5.00	.50000000	3.50102960	4.08402730	-3.30973110	660
-0.31832840	FR 5.00	.99999996	5.17462620	2.70095880	-2.22254300	661
-17062610	FR 5.00	1.49999990	6.29258670	1.86148460	-1.13535440	662
-0.12237409	FR 5.00	1.99999990	7.12671050	1.56560450	-0.04816638	663
-0.06873381	FR 5.00	2.00000000	7.12671080	1.56560430	-0.04816611	664
0.06958540	FR 5.00	2.49999990	7.90110650	1.52721330	-0.10539841	665
	FR 5.00	2.99999990	8.64915380	1.46020660	-0.16263061	666
	FR 5.00	3.49999990	9.35654500	1.36458210	-0.21986277	667
	FR 5.00	3.99999980	10.00896700	1.24034310	-0.27709500	668
	FR 5.00	4.00000000	10.00896800	1.24034280	-0.27709500	669
	FR 5.00	4.49999980	10.59561500	1.10847360	-0.25038183	670
	FR 5.00	4.99999980	11.11966700	.98996155	-0.22366891	671
	FR 5.00	5.49999980	11.58780200	.88480531	-0.19695547	672
	FR 5.00	5.99999980	12.00669900	.79300660	-0.17024225	673
	FR 5.00	6.49999920	12.38302400	.71456203	-0.14352936	674
	FR 5.00	6.99999900	12.72347200	.64947511	-0.11681622	675
	FR 5.00	7.49999980	13.03472700	.59774588	-0.09010305	676
	FR 5.00	7.99999980	13.32345300	.55937265	-0.06338988	677
	FR 5.00	7.99999980	13.32345500	.55937180	-0.06338997	678
	FR 5.00	8.49999980	13.59539200	.52872565	-0.05920285	679
	FR 5.00	8.99999980	13.85252400	.50016988	-0.05501587	680
	FR 5.00	9.49999980	14.09589700	.47370518	-0.05082891	681
	FR 5.00	9.99999780	14.32657500	.44933858	-0.04664193	682
	FR 5.00	10.49999800	14.54560300	.42706820	-0.04245495	683
	FR 5.00	10.99999700	14.75398500	.40688756	-0.03826769	684
	FR 5.00	11.49999700	14.95282700	.38879620	-0.03408102	685
	FR 5.00	11.99999700	15.14315300	.37280623	-0.02989376	686
	FR 5.00	12.00000000	15.14314900	.37280485	-0.02989395	687
	FR 5.00	12.49999700	15.32596000	.35878738	-0.02616063	688
	FR 5.00					689
	FR 5.00					690
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	FR 5.00					694
	FR 5.00					695
	FR 5.00					696
	FR 5.00					697

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FR	5.00	12.99999700	15.50223600	.34665783	-.02242806	698
FR	5.00	13.49999600	15.67294500	.33637113	-.01869382	699
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 1.01222280

SECOND DER.

-.31795838
 -.89509286
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 -.04624086
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 .05090934
 .05813819
 .05813826

.10035185
 .11316575
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 .14961689
 .17328750
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 .20053105

24.68723600
 24.74019500
 24.80110300
 24.87051500
 24.95098900
 25.04437400
 25.04445400
 25.04445400

C.29

FR	8.00	7.49999880	20.53837400	.93731550	--.16131694	985
FR	8.00	7.99999860	20.98590800	.85090500	--.18433250	986
FR	8.00	7.99999980	20.98591000	.85090333	--.18433250	987
FR	8.00	8.49999840	21.38897800	.76270833	--.16844564	988
FR	8.00	8.99999820	21.74994400	.68245876	--.15255842	989
FR	8.00	9.49999800	22.07277600	.61015315	--.13667148	990
FR	8.00	9.99999780	22.36141300	.54578696	--.12078481	991
FR	8.00	10.49999800	22.61987300	.48936190	--.10489788	992
FR	8.00	10.99999700	22.85210900	.44088791	--.08901066	993
FR	8.00	11.49999700	23.06208600	.40035505	--.07312400	994
FR	8.00	11.9999700	23.25378200	.36775995	--.05723702	995
FR	8.00	12.0000000	23.25378400	.36776088	--.05723680	996
FR	8.00	12.49999700	23.43065600	.33995310	--.05401468	997
FR	8.00	12.9999700	23.59402200	.31374820	--.05079268	998
FR	8.00	13.49999600	23.74465200	.28915191	--.04757041	999
FR	8.00	13.99999600	23.88345300	.26618428	--.04434759	000
FR	8.00	14.49999600	24.01110600	.24480190	--.04112726	001
FR	8.00	14.99999600	24.12853100	.22506005	--.03790444	002
FR	8.00	15.49999600	24.23638600	.20690985	--.03468133	003
FR	8.00	15.99999500	24.33574000	.19036998	--.03146101	004
FR	8.00	16.0000000	24.33574000	.19037056	--.03145828	005
FR	8.00	16.49999500	24.42710000	.17511876	--.02951918	006
FR	8.00	16.99999500	24.51108800	.16083537	--.02757708	007
FR	8.00	17.49999500	24.58787200	.14752019	--.02563805	008
FR	8.00	17.99999500	24.65869300	.13518818	--.02369595	009
FR	8.00	18.49999400	24.72343900	.12384437	--.02175413	010
FR	8.00	18.99999400	24.78263800	.11343357	--.01981482	011
FR	8.00	19.49999400	24.83708200	.10400916	--.01787300	012
FR	8.00	19.99999400	24.88687800	.09556475	--.01593091	013
FR	8.00	20.0000000	24.88682700	.09555229	--.01593310	014
FR	8.00	20.49999400	24.93281000	.08805162	--.01413190	015
FR	8.00	20.99999300	24.97506500	.08141302	--.01233040	016
FR	8.00	21.49999300	25.01432100	.07573259	--.01052861	017
FR	8.00	21.99999300	25.05108000	.07092674	--.00872989	018
FR	8.00	22.49999300	25.08544700	.06697875	--.00692811	019
FR	8.00	22.99999300	25.11832700	.06400544	--.00512660	020
FR	8.00	23.49999200	25.14961700	.06187335	--.00332758	021
FR	8.00	23.99999200	25.18012900	.06064954	--.00152582	022
FR	8.00	24.0000000	25.18029300	.06065670	--.00152515	023
FR	8.00	24.49999200	25.21021900	.05943421	--.00332399	024
FR	8.00	24.99999200	25.23932800	.05731131	--.00511944	025

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0-31

FR	8.00	25.49999200	25.26737300	.05431432	--.00691489	026
FR	8.00	25.99999100	25.29385700	.05042657	--.00871593	027
FR	8.00	26.49999100	25.49999100	.04554790	--.01051137	028
FR	8.00	26.99999100	25.33904900	.03991130	--.01230680	029
FR	8.00	27.49999100	25.35737300	.03326812	--.01410505	030
FR	8.00	27.99999100	25.37185100	.02578438	--.01590051	031
FR	8.00	28.00000000	25.37225900	.02576082	--.01590290	032
FR	8.00	28.49999000	25.38314000	.01828278	--.01406630	033
FR	8.00	28.99999000	25.39100300	.01173977	--.01223480	034
FR	8.00	29.49999000	25.39484900	.00602005	--.01040333	035
FR	8.00	29.99999000	25.35688100	.00129177	--.00856906	036
FR	8.00	30.49999000	25.39652700	--.00251374	--.00674035	037
FR	8.00	30.99998900	25.39510300	--.00546130	--.00490607	038
FR	8.00	31.49998900	25.39141000	--.00743374	--.00307183	039
FR	8.00	31.99998900	25.38855700	--.00848226	--.00124033	040
FR	8.00	32.00000000	25.38783600	--.00851838	--.00123980	041
FR	8.00	32.49998900	25.38353900	--.00577570	--.01218674	042
FR	8.00	32.99998900	25.38329200	.00366801	.02561127	043
FR	8.00	33.49998800	25.38871600	.01983183	.03903582	044
FR	8.00	33.99998800	25.40502600	.04271666	.05246316	045
FR	8.00	34.49998800	25.43264400	.07227243	.06589049	046
FR	8.00	34.99998800	25.47736600	.10861453	.07931502	047
FR	8.00	35.49998800	25.54240500	.15157756	.09274235	048
FR	8.00	35.99998700	25.63076200	.20134560	.10616968	049
FR	8.00	36.00000000	25.63024900	.20131470	.10616780	050
PEN UP	6000.00000000					051
GO TO	1.00000000		25.63024900			052
	87.68152700					053
	-222.34281000					054
	222.35564000					055
	-230.44186000					056
	11.22215000					057
	-2.81541000					058
	--.21233630					059
	.30957680					060
	--.36421070					061
	--.12318330					062
	.13419310					063
	.03699559					064
IDENT.						065
						066

IDENT. Z

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FIRST DER.

SECOND DER.

FR	9.00	.00000000	1.00000000	14.61358700	-12.35237800	067
PEN	DOWN	5000.00000000	6.89142470	9.20946680	-9.26410550	068
FR	9.00	.50000000	10.46682300	5.34948260	-6.17583330	069
FR	9.00	.99999996	12.49826300	3.03363300	-3.08756050	070
FR	9.00	1.49999990	13.75781200	2.26192160	.00071194	071
FR	9.00	1.99999990	13.75781200	2.26192100	.00071222	072
FR	9.00	2.00000000	14.88418400	2.23420000	-1.1159638	073
FR	9.00	2.49999990	15.98265700	2.15032600	-2.2390527	074
FR	9.00	2.99999990	17.02515000	2.01029630	-3.3621388	075
FR	9.00	3.49999990	17.98359600	1.81411060	-4.4852277	076
FR	9.00	4.00000000	17.98359300	1.81411110	-4.4852305	077
FR	9.00	4.49999980	18.83639700	1.60073910	-4.40496825	078
FR	9.00	4.99999980	19.58795600	1.40914480	-3.6141422	079
FR	9.00	5.49999980	20.24918100	1.23932710	-3.1786019	080
FR	9.00	5.99999980	20.83091600	1.09128600	-2.7430616	081
FR	9.00	6.49999920	21.34405700	.96501801	-2.3075358	082
FR	9.00	6.99999900	21.79955800	.86053318	-1.8719602	083
FR	9.00	7.49999980	22.20825300	.77782150	-1.4364122	084
FR	9.00	7.99999860	22.58102800	.71689316	-1.0008641	085
FR	9.00	7.99999980	22.58102200	.71689800	-1.0008883	086
FR	9.00	8.49999840	22.92714100	.66796400	-0.9563719	087
FR	9.00	8.99999820	23.24935000	.62127321	-0.9118531	088
FR	9.00	9.49999800	23.54874500	.57679415	-0.8673341	089
FR	9.00	9.99999780	23.82651600	.53454365	-0.8228428	090
FR	9.00	10.49999800	24.08362400	.49448986	-0.7783238	091
FR	9.00	10.99999700	24.32135700	.45669965	-0.7337772	092
FR	9.00	11.49999700	24.54074600	.42112231	-0.6892582	093
FR	9.00	11.99999700	24.74293200	.38777538	-0.6447669	094
FR	9.00	12.00000000	24.74296200	.38776560	-0.6447602	095
FR	9.00	12.49999700	24.92879300	.35592140	-0.6297390	096
FR	9.00	12.99999700	25.09885000	.32480625	-0.6147101	097
FR	9.00	13.49999600	25.25366300	.29444676	-0.5997107	098
FR	9.00	13.99999600	25.39337700	.26484260	-0.5846838	099
FR	9.00	14.49999600	25.51855000	.23597693	-0.5696566	100
FR	9.00	14.99999600	25.62953300	.20785055	-0.5545991	101
FR	9.00	15.49999600	25.72657900	.18049676	-0.5395997	102
FR	9.00	15.99999500	25.81023900	.15391543	-0.5245728	103
FR	9.00	16.00000000	25.81042200	.15392766	-0.5245900	104
FR	9.00	16.49999500	25.88095000	.12914611	-0.5245900	105
FR	9.00	16.99999500	25.93985100	.10728407	-0.4665464	106
FR	9.00	16.99999500			-0.4085225	107

FR	9.00	17.49999500	25.98868500	-.08830914	-.03505266	108
FR	9.00	17.49999500	26.02855500	.07224133	-.02925026	109
FR	9.00	18.49999400	26.06111300	.059202746	-.02344762	110
FR	9.00	18.49999400	26.08848100	.04875238	-.01764522	111
FR	9.00	19.49999400	26.11078200	.04139958	-.01184285	112
FR	9.00	19.49999400	26.12994600	.03693556	-.00604046	113
FR	9.00	20.00000000	26.13006100	.03695981	-.00604175	114
FR	9.00	20.49999400	26.14798500	.03411240	-.00529623	115
FR	9.00	20.49999300	26.16417700	.03166561	-.00455509	116
FR	9.00	21.49999300	26.18040000	.02956151	-.00381118	117
FR	9.00	21.49999300	26.19427800	.02783381	-.00306701	118
FR	9.00	22.49999300	26.20722300	.02649933	-.00232588	119
FR	9.00	22.49999300	26.22093900	.02545403	-.00157921	120
FR	9.00	23.49999200	26.23414800	.02493862	-.00083530	121
FR	9.00	23.49999200	26.24648900	.02483257	-.00009113	122
FR	9.00	24.00000000	26.24591900	.02472409	-.00009236	123
FR	9.00	24.49999200	26.25793500	.02450522	-.00106085	124
FR	9.00	24.49999200	26.27044700	.02375379	-.00202781	125
FR	9.00	25.49999200	26.28178200	.02248463	-.00299452	126
FR	9.00	25.49999100	26.29083900	.02072139	-.00396148	127
FR	9.00	26.49999100	26.30246400	.01863393	-.00493125	128
FR	9.00	26.49999100	26.31139400	.01570641	-.00589544	129
FR	9.00	27.49999100	26.31755000	.01262365	-.00686215	130
FR	9.00	27.49999100	26.32477100	.00887816	-.00783189	131
FR	9.00	28.00000000	26.32343700	.00893005	-.00783268	132
FR	9.00	28.49999000	26.32796000	.00527089	-.00693512	133
FR	9.00	28.49999000	26.32726900	.00209361	-.00603829	134
FR	9.00	29.49999000	26.32908100	-.00064784	-.00514119	135
FR	9.00	29.49999000	26.32672600	-.00294512	-.00424716	136
FR	9.00	30.49999000	26.32540500	-.00497993	-.00334756	137
FR	9.00	30.49998900	26.32348900	-.00657558	-.00245048	138
FR	9.00	31.49998900	26.32120200	-.00757196	-.00155643	139
FR	9.00	31.49998900	26.31488200	-.00796763	-.00065963	140
FR	9.00	32.00000000	26.31503100	-.00806053	-.00065998	141
FR	9.00	32.49998900	26.31199400	-.00795890	.00075101	142
FR	9.00	32.49998900	26.30776200	-.00726425	.00216194	143
FR	9.00	33.49998800	26.30358300	-.00570174	.00356960	144
FR	9.00	33.49998800	26.30018900	-.00361985	.00498045	145
FR	9.00	34.49998800	26.30156500	-.00051021	.00639386	146
FR	9.00	34.49998800	26.29954800	.00262544	.00780479	147
FR	9.00	35.49998800	26.30334200	.00695561	.00921265	148

1 51 0

FR	9.00	35.99998700	26.30649000	.01181346	.01062330	149
FR	9.00	36.00000000	26.30907400	.01207516	.01062334	150
PEN UP		6000.00000000				151
GO TO		.00000000	26.30907400			152

c-24

DLG 26 CENTER SECT 11X7 WATERLINES

1.9.0

IDENT.	X	Y	FIRST DER.	SECOND DER.
WL .00	3.00000000	1.00000000	.00000000	.00000000
PEN DOWN	5000.00000000			
WL .00	3.20000000	1.00000000	.00000000	.00000000
WL .00	3.40000000	1.00000000	.00000000	.00000000
WL .00	3.60000000	1.00000000	.00000000	.00000000
WL .00	3.80000000	1.00000000	.00000000	.00000000
WL .00	4.00000000	1.00000000	.00000000	.00000000
WL .00	4.20000000	1.00000000	.00000000	.00000000
WL .00	4.40000000	1.00000000	.00000000	.00000000
WL .00	4.60000000	1.00000000	.00000000	.00000000
WL .00	4.80000000	1.00000000	.00000000	.00000000
WL .00	5.00000000	1.00000000	.00000000	.00000000
WL .00	5.20000000	1.00000000	.00000000	.00000000
WL .00	5.40000000	1.00000000	.00000000	.00000000
WL .00	5.60000000	1.00000000	.00000000	.00000000
WL .00	5.80000000	1.00000000	.00000000	.00000000
WL .00	6.00000000	1.00000000	.00000000	.00000000
WL .00	6.20000000	1.00000000	.00000000	.00000000
WL .00	6.40000000	1.00000000	.00000000	.00000000
WL .00	6.60000000	1.00000000	.00000000	.00000000
WL .00	6.80000000	1.00000000	.00000000	.00000000
WL .00	7.00000000	1.00000000	.00000000	.00000000
WL .00	7.20000000	1.00000000	.00000000	.00000000
WL .00	7.40000000	1.00000000	.00000000	.00000000
WL .00	7.60000000	1.00000000	.00000000	.00000000
WL .00	7.80000000	1.00000000	.00000000	.00000000
WL .00	8.00000000	1.00000000	.00000000	.00000000
WL .00	8.20000000	1.00000000	.00000000	.00000000
WL .00	8.40000000	1.00000000	.00000000	.00000000
WL .00	8.60000000	1.00000000	.00000000	.00000000
WL .00	8.80000000	1.00000000	.00000000	.00000000
WL .00	9.00000000	1.00000000	.00000000	.00000000
PEN UP	6000.00000000			

C-35

1.5.0

GO TO	3.00000000
	4.05356770
	2.91016700
	.08526700
	.07770300
	-.18201400
	-.43579200
IDENT.	X
WL 2.00	3.00000000
PEN DOWN	5000.00000000
WL 2.00	3.20000000
WL 2.00	3.40000000
WL 2.00	3.60000000
WL 2.00	3.80000000
WL 2.00	4.00000000
WL 2.00	4.20000000
WL 2.00	4.40000000
WL 2.00	4.60000000
WL 2.00	4.80000000
WL 2.00	5.00000000
WL 2.00	5.20000000
WL 2.00	5.40000000
WL 2.00	5.60000000
WL 2.00	5.80000000
WL 2.00	6.00000000
WL 2.00	6.20000000
WL 2.00	6.40000000
WL 2.00	6.60000000
WL 2.00	6.80000000
WL 2.00	7.00000000
WL 2.00	7.20000000
WL 2.00	7.40000000
WL 2.00	7.60000000
WL 2.00	7.80000000
WL 2.00	8.00000000
WL 2.00	8.20000000
WL 2.00	8.40000000
WL 2.00	8.60000000
WL 2.00	8.80000000
WL 2.00	9.00000000
PEN UP	6000.00000000

1.00000000

	Y	FIRST DER.	SECOND DER.
	4.05356770	1.45508350	.04263350
	4.34551470	1.46477570	.05428895
	4.63963330	1.47679900	.06594440
	4.93638970	1.49115350	.07759985
	5.23625010	1.50783900	.08925530
	5.53968070	1.52685560	.10091075
	5.84714780	1.54820330	.11256620
	6.15911750	1.57188210	.12422165
	6.47605600	1.59789190	.13587710
	6.79842960	1.62623290	.14753255
	7.12670470	1.65690500	.15918800
	7.46116500	1.68717790	.171354135
	7.80136710	1.71432150	.182789470
	8.14668510	1.73833580	.19224805
	8.49649300	1.75922070	.200660140
	8.85016480	1.77697630	.208095475
	9.20707480	1.79160260	.214530810
	9.56659720	1.80309960	.2204966145
	9.92810600	1.81114670	.225401480
	10.29097500	1.81670550	.23041836815
	10.65457900	1.81881450	.235272150
	11.01785700	1.81125730	.2407829395
	11.37800200	1.78749700	.24615930940
	11.73177500	1.74753350	.251424032485
	12.07593500	1.69136700	.256532134030
	12.40724100	1.61899740	.26140235575
	12.72245200	1.53042470	.26648337120
	13.01833200	1.42564890	.27156438665
	13.29163400	1.30467000	.27664540210
	13.53911900	1.16748800	.28172641755
	13.75754800	1.01410300	.28680743300

042
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C.36

1.6.6

GO TO	3.00000000	
	5.64452410	
	4.68439100	
	-.74822800	
	.42832200	
	-.82304900	
	.03928900	
IDENT.	X	
WL	4.00	3.00000000
PEN DOWN	5000.00000000	
WL	4.00	3.20000000
WL	4.00	3.40000000
WL	4.00	3.60000000
WL	4.00	3.80000000
WL	4.00	4.00000000
WL	4.00	4.20000000
WL	4.00	4.40000000
WL	4.00	4.60000000
WL	4.00	4.80000000
WL	4.00	5.00000000
WL	4.00	5.20000000
WL	4.00	5.40000000
WL	4.00	5.60000000
WL	4.00	5.80000000
WL	4.00	6.00000000
WL	4.00	6.20000000
WL	4.00	6.40000000
WL	4.00	6.60000000
WL	4.00	6.80000000
WL	4.00	7.00000000
WL	4.00	7.20000000
WL	4.00	7.40000000
WL	4.00	7.60000000
WL	4.00	7.80000000
WL	4.00	8.00000000
WL	4.00	8.20000000
WL	4.00	8.40000000
WL	4.00	8.60000000
WL	4.00	8.80000000
WL	4.00	9.00000000
PEN UP	6000.00000000	

13.75754800

FIRST DER.	SECOND DER.
2.34219550	-.37411400
2.27379750	-.30986570
2.21824920	-.24561740
2.17555050	-.18136910
2.14570150	-.11712080
2.12870220	-.05287250
2.12455250	.01137580
2.13325250	-.07562410
2.15480220	.13987240
2.18920150	.20412070
2.23645050	.26836900
2.28420340	.20915995
2.32011450	.14995090
2.34418370	.09074185
2.35641120	.03153280
2.35679690	-.02767625
2.34534070	-.08688530
2.32204270	-.14609435
2.28690290	-.20530340
2.23992140	-.26451245
2.18109800	-.32372150
2.11102210	-.37703720
2.03028300	-.43035290
1.93888090	-.48366860
1.83681570	-.53698430
1.72408720	-.59030000
1.60069570	-.64361570
1.46664090	-.69693140
1.32192290	-.75024710
1.16654210	-.80356280
1.00049800	-.85687850

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GO TO	3.00000000
	7.52184390
	5.05787700
	1.21735000
	-.47362700
	.16680100
	.37652400
IDENT.	X
WL 8.00	3.00000000
PEN DOWN	5000.00000000
WL 8.00	3.20000000
WL 8.00	3.40000000
WL 8.00	3.60000000
WL 8.00	3.80000000
WL 8.00	4.00000000
WL 8.00	4.20000000
WL 8.00	4.40000000
WL 8.00	4.60000000
WL 8.00	4.80000000
WL 8.00	5.00000000
WL 8.00	5.20000000
WL 8.00	5.40000000
WL 8.00	5.60000000
WL 8.00	5.80000000
WL 8.00	6.00000000
WL 8.00	6.20000000
WL 8.00	6.40000000
WL 8.00	6.60000000
WL 8.00	6.80000000
WL 8.00	7.00000000
WL 8.00	7.20000000
WL 8.00	7.40000000
WL 8.00	7.60000000
WL 8.00	7.80000000
WL 8.00	8.00000000
WL 8.00	8.20000000
WL 8.00	8.40000000
WL 8.00	8.60000000
WL 8.00	8.80000000
WL 8.00	9.00000000
PEN UP	6000.00000000

17.98323600

	Y	FIRST DER.	SECOND DER.
	7.52184390	2.52893850	.60867500
	8.03933150	2.64356910	.53763095
	8.57832430	2.74399090	.46658690
	9.13598060	2.83020390	.39554285
	9.70945860	2.90220800	.32449880
	10.29591600	2.96000340	.25345475
	10.89251300	3.00358990	.18241070
	11.49640400	3.03296770	.11136665
	12.10475200	3.04813660	.04032260
	12.71471200	3.04909670	-.03072145
	13.32344300	3.03584800	-.10176550
	13.92827000	3.01089250	-.14778940
	14.52718700	2.97673220	-.19381330
	15.11835000	2.93336710	-.23983720
	15.69992000	2.88079730	-.28586110
	16.27005500	2.81902270	-.33188500
	16.82691600	2.74804330	-.37790890
	17.36865800	2.66785910	-.42393280
	17.89344600	2.57847020	-.46995670
	18.39943300	2.47987650	-.51598060
	18.88478200	2.37207800	-.56200450
	19.34802700	2.26072260	-.55154980
	19.78921000	2.15145800	-.54109510
	20.20874900	2.04428470	-.53064040
	20.60706300	1.93920210	-.52018570
	20.98457000	1.83621040	-.50973100
	21.34168600	1.73530980	-.49927630
	21.67883200	1.63649990	-.48882160
	21.99642600	1.53978080	-.47836690
	22.29488500	1.44515300	-.46791220
	22.57462700	1.35261600	-.45745750

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GO TO	3.00000000	
	8.44555900	
	6.59258210	
	-32863440	
	-22329350	
	-07733570	
	-19862320	
IDENT.	X	
WL 12.00	3.00000000	
PEN DOWN	5000.00000000	
WL 12.00	3.20000000	
WL 12.00	3.40000000	
WL 12.00	3.60000000	
WL 12.00	3.80000000	
WL 12.00	4.00000000	
WL 12.00	4.20000000	
WL 12.00	4.40000000	
WL 12.00	4.60000000	
WL 12.00	4.80000000	
WL 12.00	5.00000000	
WL 12.00	5.20000000	
WL 12.00	5.40000000	
WL 12.00	5.60000000	
WL 12.00	5.80000000	
WL 12.00	6.00000000	
WL 12.00	6.20000000	
WL 12.00	6.40000000	
WL 12.00	6.60000000	
WL 12.00	6.80000000	
WL 12.00	7.00000000	
WL 12.00	7.20000000	
WL 12.00	7.40000000	
WL 12.00	7.60000000	
WL 12.00	7.80000000	
WL 12.00	8.00000000	
WL 12.00	8.20000000	
WL 12.00	8.40000000	
WL 12.00	8.60000000	
WL 12.00	8.80000000	
WL 12.00	9.00000000	
PEN UP	6000.00000000	

22.57462700

	Y	
	8.44555900	
	9.10788030	
	9.77543440	
	10.44688200	
	11.12088200	
	11.79609700	
	12.47118500	
	13.14480700	
	13.81562400	
	14.48229500	
	15.14348200	
	15.79776600	
	16.44342100	
	17.07864400	
	17.70163000	
	18.31057800	
	18.90368000	
	19.47913500	
	20.03514000	
	20.56988800	
	21.08157700	
	21.56860200	
	22.03015300	
	22.46561800	
	22.87438300	
	23.25583900	
	23.60036900	
	23.93436600	
	24.23021800	
	24.49630800	
	24.75202800	

FIRST DER.
3.29629100

SECOND DER.
.16431720

3.32580500
3.34862030
3.36473670
3.37415440
3.37687320
3.37289320
3.36221440
3.34483680
3.32076040
3.28998520
3.25135110
3.20369820
3.14702640
3.08133570
3.00662620
2.92289780
2.83015050
2.72838430
2.61759920
2.49779530
2.37195180
2.24304820
2.11108420
1.97606030
1.83797610
1.69683180
1.55262720
1.40536250
1.25503750
1.10165260

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GO TO 3.00000000
 9.22798540
 7.14345760
 .59605475
 -.49219207
 .35397352
 .22964735

IDENT. X

WL 16.00 3.00000000
 PEN DOWN 5000.00000000
 WL 16.00 3.20000000
 WL 16.00 3.40000000
 WL 16.00 3.60000000
 WL 16.00 3.80000000
 WL 16.00 4.00000000
 WL 16.00 4.20000000
 WL 16.00 4.40000000
 WL 16.00 4.60000000
 WL 16.00 4.80000000
 WL 16.00 5.00000000
 WL 16.00 5.20000000
 WL 16.00 5.40000000
 WL 16.00 5.60000000
 WL 16.00 5.80000000
 WL 16.00 6.00000000
 WL 16.00 6.20000000
 WL 16.00 6.40000000
 WL 16.00 6.60000000
 WL 16.00 6.80000000
 WL 16.00 7.00000000
 WL 16.00 7.20000000
 WL 16.00 7.40000000
 WL 16.00 7.60000000
 WL 16.00 7.80000000
 WL 16.00 8.00000000
 WL 16.00 8.20000000
 WL 16.00 8.40000000
 WL 16.00 8.60000000
 WL 16.00 8.80000000
 WL 16.00 9.00000000
 PEN UP 6000.00000000

24.73202800

Y

9.22798540
 9.94779950
 10.67658100
 11.41137700
 12.14923600
 12.88720300
 13.62232600
 14.35165000
 15.07222400
 15.78109300
 16.47530500
 17.15226000
 17.81077600
 18.45002300
 19.06917200
 19.66739200
 20.24385700
 20.79773400
 21.32819600
 21.83441200
 22.31555600
 22.77102400
 23.20113900
 23.60644500
 23.98749500
 24.34483500
 24.67901600
 24.99058400
 25.28008700
 25.54807600
 25.79509900

FIRST DER.
 3.57172880

3.62395140
 3.66140820
 3.68409930
 3.69202460
 3.68518410
 3.66357790
 3.62720590
 3.57606820
 3.51016470
 3.42949540
 3.33937000
 3.24509800
 3.14667950
 3.04411440
 2.93740270
 2.82654460
 2.71153980
 2.59238840
 2.46909060
 2.34164620
 2.21349990
 2.08809650
 1.96543590
 1.84551800
 1.72834340
 1.61391140
 1.50222250
 1.39327580
 1.28707270
 1.18361220

SECOND DER.
 .29802737

.22419857
 .15036977
 .07654095
 .00271212
 -.07111667
 -.14494547
 -.21877430
 -.29260310
 -.36643192
 -.44026072
 -.46099350
 -.48172630
 -.50245907
 -.52319187
 -.54392462
 -.56465740
 -.58539020
 -.60612297
 -.62685577
 -.64758855
 -.66837422
 -.68915992
 -.70994560
 -.73073130
 -.75151695
 -.77230262
 -.79308832
 -.81387397
 -.83465967
 -.85544535

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GO TO 3.00000000
 10.10321900
 8.30684060
 --.38831670
 --.30955471
 .38878396
 --.20733644

IDENT. X
 WL 20.00 3.00000000
 PEN DOWN 5000.00000000
 WL 20.00 3.20000000
 WL 20.00 3.40000000
 WL 20.00 3.60000000
 WL 20.00 3.80000000
 WL 20.00 4.00000000
 WL 20.00 4.20000000
 WL 20.00 4.40000000
 WL 20.00 4.60000000
 WL 20.00 4.80000000
 WL 20.00 5.00000000
 WL 20.00 5.20000000
 WL 20.00 5.40000000
 WL 20.00 5.60000000
 WL 20.00 5.80000000
 WL 20.00 6.00000000
 WL 20.00 6.20000000
 WL 20.00 6.40000000
 WL 20.00 6.60000000
 WL 20.00 6.80000000
 WL 20.00 7.00000000
 WL 20.00 7.20000000
 WL 20.00 7.40000000
 WL 20.00 7.60000000
 WL 20.00 7.80000000
 WL 20.00 8.00000000
 WL 20.00 8.20000000
 WL 20.00 8.40000000
 WL 20.00 8.60000000
 WL 20.00 8.80000000
 WL 20.00 9.00000000
 PEN UP 6000.00000000

25.79509900

Y
 10.10321900
 10.92971100
 11.74657900
 12.55196600
 13.34401400
 14.12086600
 14.88066600
 15.62155500
 16.34167700
 17.03917400
 17.71218900
 18.35925100
 18.98045100
 19.57626300
 20.14716000
 20.69361800
 21.21611500
 21.71512300
 22.19112000
 22.64458100
 23.07598000
 23.48558600
 23.87283800
 24.23696500
 24.57720200
 24.89277800
 25.18292700
 25.44687500
 25.68385700
 25.89310600
 26.07384900

FIRST DER.
 4.15342030
 4.10994530
 4.05718370
 3.99513540
 3.92380050
 3.84317890
 3.75327080
 3.65407590
 3.54559440
 3.42782630
 3.30077150
 3.17026190
 3.04212910
 2.91637320
 2.79299420
 2.67199200
 2.55336680
 2.43711840
 2.32324700
 2.21175230
 2.10263450
 1.99278370
 1.87908950
 1.76155220
 1.64017160
 1.51494790
 1.38588100
 1.25297060
 1.11621720
 .97562060
 .83118075

SECOND DER.
 --.19415835
 --.24059155
 --.28702475
 --.33345795
 --.37989117
 --.42632437
 --.47275760
 --.51919080
 --.56562400
 --.61205722
 --.65849042
 --.64660605
 --.63472167
 --.62283727
 --.61095287
 --.59906850
 --.58718410
 --.57529970
 --.56341532
 --.55153095
 --.53964655
 --.55886260
 --.57807870
 --.59729477
 --.61651085
 --.63572695
 --.65494300
 --.67415907
 --.69337515
 --.71259125
 --.73180732

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GO TO 3.00000000
 11.59682400
 8.57899370
 -.81249200
 -.25244503
 .41435178
 -.15279513

IDENT. X
 WL 24.00 3.00000000
 PEN DOWN 5000.00000000
 WL 24.00 3.20000000
 WL 24.00 3.40000000
 WL 24.00 3.60000000
 WL 24.00 3.80000000
 WL 24.00 4.00000000
 WL 24.00 4.20000000
 WL 24.00 4.40000000
 WL 24.00 4.60000000
 WL 24.00 4.80000000
 WL 24.00 5.00000000
 WL 24.00 5.20000000
 WL 24.00 5.40000000
 WL 24.00 5.60000000
 WL 24.00 5.80000000
 WL 24.00 6.00000000
 WL 24.00 6.20000000
 WL 24.00 6.40000000
 WL 24.00 6.60000000
 WL 24.00 6.80000000
 WL 24.00 7.00000000
 WL 24.00 7.20000000
 WL 24.00 7.40000000
 WL 24.00 7.60000000
 WL 24.00 7.80000000
 WL 24.00 8.00000000
 WL 24.00 8.20000000
 WL 24.00 8.40000000
 WL 24.00 8.60000000
 WL 24.00 8.80000000
 WL 24.00 9.00000000
 PEN UP 6000.00000000

26.07384900

Y
 11.59682400
 12.24634700
 13.07810400
 13.89058200
 14.68226700
 15.45164200
 16.19719500
 16.91741000
 17.61077400
 18.27576800
 18.91088000
 19.51501200
 20.08871700
 20.63297100
 21.14874000
 21.63700000
 22.09872000
 22.53487200
 22.94642800
 23.33435800
 23.69963400
 24.04307900
 24.36489200
 24.66513500
 24.944385900
 25.20111800
 25.43697100
 25.65146800
 25.84466400
 26.01661900
 26.16738100

FIRST DER.
 4.28949680
 4.20446100
 4.11185170
 4.01166920
 3.90391320
 3.78858400
 3.66568130
 3.53520540
 3.39715600
 3.25153330
 3.09833730
 2.94378320
 2.79408630
 2.64924650
 2.50926410
 2.37415880
 2.24387070
 2.11845970
 1.99790600
 1.88220960
 1.77137030
 1.66309630
 1.55509560
 1.44736840
 1.33991440
 1.23273370
 1.12582650
 1.01919260
 .91283195
 .80674470
 .70093085

SECOND DER.
 -.40624600
 -.44411275
 -.48197950
 -.51984625
 -.55771300
 -.59557977
 -.63344652
 -.67131327
 -.70918005
 -.74704680
 -.78491355
 -.76062755
 -.73634152
 -.71205552
 -.68776952
 -.66348347
 -.63919747
 -.61491145
 -.59062545
 -.56633945
 -.54205342
 -.54068665
 -.53931992
 -.53795320
 -.53658645
 -.53521967
 -.53385295
 -.53248620
 -.53111947
 -.52975275
 -.52838597

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GO TO 3.00000000
13.07129200
8.63354940
-1.32652980
-.16522285
.52109964
-.42319729
IDENT. X
WL 28.00 3.00000000
PEN DOWN 5000.00000000
WL 28.00 3.20000000
WL 28.00 3.40000000
WL 28.00 3.60000000
WL 28.00 3.80000000
WL 28.00 4.00000000
WL 28.00 4.20000000
WL 28.00 4.40000000
WL 28.00 4.60000000
WL 28.00 4.80000000
WL 28.00 5.00000000
WL 28.00 5.20000000
WL 28.00 5.40000000
WL 28.00 5.60000000
WL 28.00 5.80000000
WL 28.00 6.00000000
WL 28.00 6.20000000
WL 28.00 6.40000000
WL 28.00 6.60000000
WL 28.00 6.80000000
WL 28.00 7.00000000
WL 28.00 7.20000000
WL 28.00 7.40000000
WL 28.00 7.60000000
WL 28.00 7.80000000
WL 28.00 8.00000000
WL 28.00 8.20000000
WL 28.00 8.40000000
WL 28.00 8.60000000
WL 28.00 8.80000000
WL 28.00 9.00000000
PEN UP 6000.00000000

26.16738100

Y
13.07129200
13.92121600
14.74361900
15.53750800
16.30189300
17.03578200
17.73818300
18.40810600
19.04455800
19.64655000
20.21309000
20.74370500
21.24001100
21.70414600
22.13824200
22.54443400
22.92486000
23.28165300
23.61694900
23.93288200
24.23158900
24.51478200
24.78248000
25.03427700
25.26977300
25.48856000
25.69023700
25.87439800
26.04064000
26.18856100
26.31775500

FIRST DER.
4.31677470
4.18164340
4.04155540
3.89651070
3.74650930
3.59155120
3.43163650
3.26676510
3.09693690
2.92215210
2.74241060
2.56552890
2.39932350
2.24379450
2.09894170
1.96476520
1.84126500
1.72844120
1.62629360
1.53482240
1.45402740
1.37756080
1.29907460
1.21856870
1.13604330
1.05149820
.96493365
.87634925
.78574540
.69312185
.59847860

SECOND DER.
-.66326490
-.68804832
-.71283175
-.73761517
-.76239860
-.78718202
-.81196545
-.83674887
-.86153230
-.88631572
-.91109917
-.85771767
-.80433615
-.75095462
-.69757310
-.64419160
-.59081007
-.53742855
-.48404705
-.43066552
-.37728400
-.38738205
-.39748012
-.40757822
-.41767630
-.42777440
-.43787245
-.44797052
-.45806862
-.46816667
-.47826475

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GO TO 3.00000000
 15.28223700
 8.09861500
 -1.67710880
 -.11039778
 .65590317
 -.59285533

IDENT.	X
WL 32.00	3.00000000
PEN DOWN	5000.00000000
WL 32.00	3.20000000
WL 32.00	3.40000000
WL 32.00	3.60000000
WL 32.00	3.80000000
WL 32.00	4.00000000
WL 32.00	4.20000000
WL 32.00	4.40000000
WL 32.00	4.60000000
WL 32.00	4.80000000
WL 32.00	5.00000000
WL 32.00	5.20000000
WL 32.00	5.40000000
WL 32.00	5.60000000
WL 32.00	5.80000000
WL 32.00	6.00000000
WL 32.00	6.20000000
WL 32.00	6.40000000
WL 32.00	6.60000000
WL 32.00	6.80000000
WL 32.00	7.00000000
WL 32.00	7.20000000
WL 32.00	7.40000000
WL 32.00	7.60000000
WL 32.00	7.80000000
WL 32.00	8.00000000
WL 32.00	8.20000000
WL 32.00	8.40000000
WL 32.00	8.60000000
WL 32.00	8.80000000
WL 32.00	9.00000000
PEN UP	6000.00000000

26.31775500

Y
 15.28223700
 16.07521700
 16.83399300
 17.55790200
 18.24628100
 18.89846800
 19.51380200
 20.09161800
 20.63125700
 21.13205300
 21.59334700
 22.01512800
 22.40001900
 22.75129000
 23.07221100
 23.36606100
 23.63610900
 23.88562900
 24.11789500
 24.33617900
 24.54375300
 24.74330200
 24.93512700
 25.11895000
 25.29448500
 25.46144700
 25.61955200
 25.76851900
 25.90806000
 26.03789300
 26.15773300

FIRST DER.	SECOND DER.
4.04930750	-.83855440
3.87994070	-.85511405
3.70726190	-.87167372
3.53127110	-.88823340
3.35196850	-.90479305
3.16935390	-.92135272
2.98342740	-.93791240
2.79418900	-.95447205
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2.40577630	-.98759140
2.20660200	-1.00415100
2.01395430	-.92232525
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1.67775460	-.75867362
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1.01655790	-.18589300
.97866915	-.19299547
.93935980	-.2009797
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.85647965	-.21430295
.81290875	-.22140545
.76791740	-.22850795
.72150560	-.23561042
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.62442040	-.24981542
.57374695	-.25691790

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GO TO	3.00000000	
18.08201300		
8.07523430		
-4.16930640		
1.01104600		
-68482970		
-71760280		
IDENT.	X	
WL 36.00	3.00000000	
PEN DOWN	5000.00000000	
WL 36.00	3.20000000	
WL 36.00	3.40000000	
WL 36.00	3.60000000	
WL 36.00	3.80000000	
WL 36.00	4.00000000	
WL 36.00	4.20000000	
WL 36.00	4.40000000	
WL 36.00	4.60000000	
WL 36.00	4.80000000	
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WL 36.00	5.20000000	
WL 36.00	5.40000000	
WL 36.00	5.60000000	
WL 36.00	5.80000000	
WL 36.00	6.00000000	
WL 36.00	6.20000000	
WL 36.00	6.40000000	
WL 36.00	6.60000000	
WL 36.00	6.80000000	
WL 36.00	7.00000000	
WL 36.00	7.20000000	
WL 36.00	7.40000000	
WL 36.00	7.60000000	
WL 36.00	7.80000000	
WL 36.00	8.00000000	
WL 36.00	8.20000000	
WL 36.00	8.40000000	
WL 36.00	8.60000000	
WL 36.00	8.80000000	
WL 36.00	9.00000000	
PEN UP	6000.00000000	
GO TO	3.00000000	

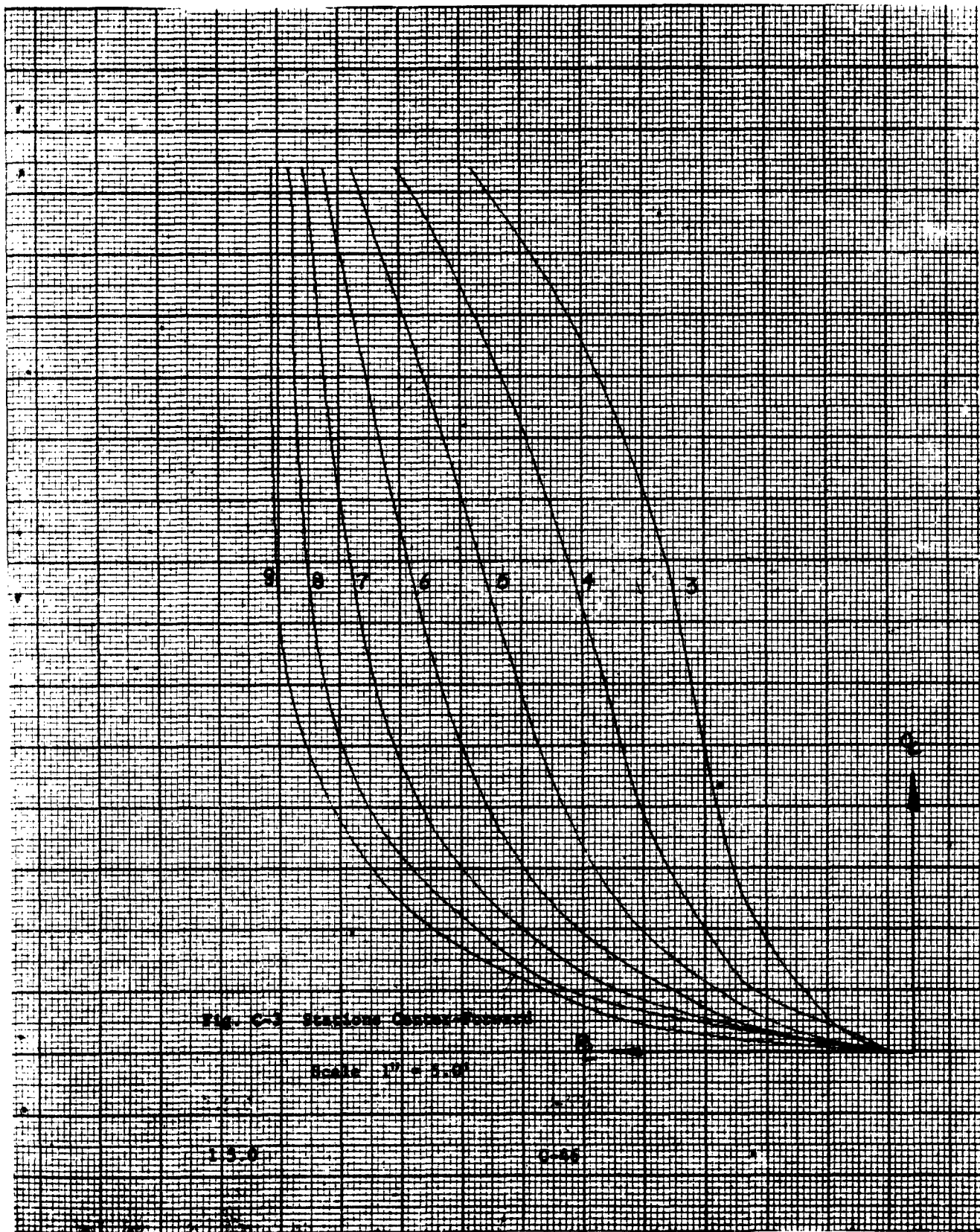
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25.60852800	
25.70319000	
25.78061600	
25.83845100	
25.87434700	
25.88596200	
25.88596200	

FIRST DER.	SECOND DER.
4.03761710	-2.08465320
3.63585220	-1.93299630
3.26441860	-1.78133940
2.92331640	-1.62968250
2.61254560	-1.47802560
2.33210620	-1.32636870
2.08199810	-1.17471180
1.86222140	-1.02305490
1.67277620	-0.87139800
1.51366230	-0.71974110
1.38487970	-0.56808420
1.27615620	-0.51915175
1.17721910	-0.47021930
1.08806810	-0.42128687
1.00870410	-0.37235442
.93912665	-0.32342197
.87933565	-0.27448952
.82933055	-0.22555692
.78911255	-0.17662440
.75868090	-0.12769210
.73803545	-0.07875955
.71641310	-0.13746742
.68304870	-0.19617554
.63794285	-0.25488342
.58109505	-0.31359155
.51250620	-0.37229942
.43217545	-0.43100730
.34010270	-0.48971542
.23628895	-0.54842330
.12073375	-0.60713142
-.00656320	-0.66583930

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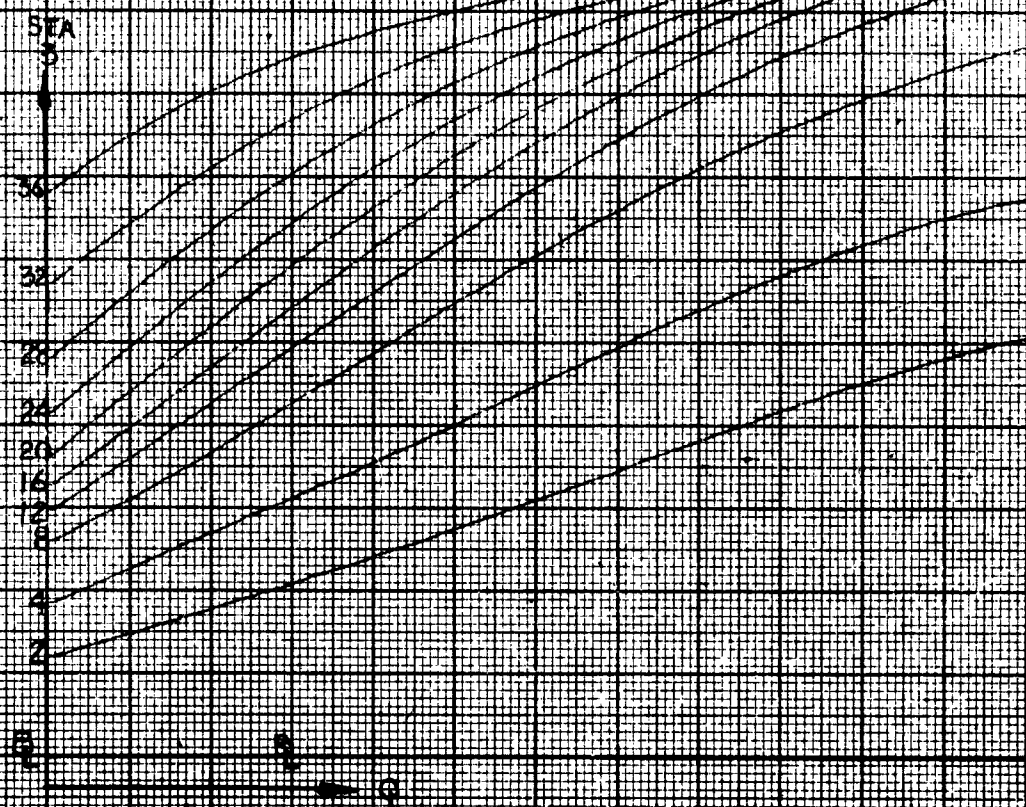


FIG. 4-4 INTERLINES - CONSECUTIVE

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1-1-1

CENTER CENTER SURFACE OF DLG-26

Project Description:

To fair a surface of nine waterlines and eleven stations taken from the preliminary offsets for the hull of DLG-26. The object was to investigate more fully the problem of large slopes at the keel line and to try a very simple overlapping procedure between this surface and the next surface forward.

Data Used:

The offsets to be used were taken from Station 8 through Station 14 of the hull at Waterlines 0 to 32 at four-foot intervals of the offsets, except those of Station 9 which were taken from the preliminary offsets. The Station 9 offsets were taken from the forward surface.

Procedure:

The matrix was punched using SMOG-1 in the dual lambda formulation with double spline in the X direction only, then the entry for the lambda row in the deviation constraints of the offsets from Station 9 were removed. This required the surface to go exactly through these offsets. A basic feasible solution was included with the matrix. This problem was run on the IBM-7090 using LP-90 and required fifty-four minutes. The surface equation was solved with GOBACK-1 on the IBM-1620.

Results:

The surface fit the offsets to a deviation of $\lambda = .03'$. The surface did go exactly through the given offsets of Station 9. Station 9, however, has a different shape on this surface than on the forward surface, causing a line of discontinuity between the surfaces at the intersections.

Recommendations:

More sophisticated means for joining surfaces should be investigated. In addition, it seems that a better surface would result from requiring a specific sign on the curvature in the Z direction at the baseline.

* DLG 26 7X9 CTR CTR

10	7	0.	0.0001
0.			
153.0000		1.000000	
178.5000		1.000000	
204.0000		1.000000	
239.5000		1.000000	
265.0000		1.000000	
290.5000		1.000000	
316.0000		1.000000	
2.0000			
153.0000	12.427083		
178.5	13.7578		
204.0000	14.250000		
239.5000	13.593750		
265.0000	11.531250		
290.5000	8.041667		
316.0000	3.520833		
4.0000			
153.0000	16.593750		
178.5	17.98359		
204.0000	18.677083		
239.5000	18.437500		
265.0000	17.291667		
290.5000	14.625000		
316.0000	10.197917		
8.0000			
153.0000	21.000000		
178.5	22.5810		
204.0000	23.458333		
239.5000	23.791667		
265.0000	23.468750		
290.5000	22.375000		
316.0000	20.281250		
12.0000			
153.0000	23.239583		
178.5	24.74296		
204.0000	25.760417		
239.5000	26.156250		
265.0000	26.062500		
290.5000	25.583333		
316.0000	24.718750		
16.0000			
153.0000	24.364583		
178.5	25.81042		

204.0000	26.708333	
239.5000	27.187500	
265.0000	27.125000	
290.5000	26.864583	
316.0000	26.354167	
20.0000		
153.0000	24.885417	
178.5	26.130061	
204.0000	26.895833	
239.5000	27.291667	
265.0000	27.375000	
290.5000	27.166667	
316.0000	26.760417	
24.0000		
153.0000	25.208333	
178.5	26.24592	
204.0000	26.895833	
239.5000	27.249583	
265.0000	27.364583	
290.5000	27.229167	
316.0000	26.822917	
28.0000		
153.0000	25.416667	
178.5	26.32344	
204.0000	26.843750	
239.5000	27.187500	
265.0000	27.291667	
290.5000	27.250000	
316.0000	26.822917	
32.0000		
153.0000	25.510417	
178.5	26.31503	
204.0000	26.739583	
239.5000	27.093750	
265.0000	27.208333	
290.5000	27.166667	
316.0000	26.791667	
51.0	8.0	153.0

DLG CTR CTR STATIONS		Y		Z		FIRST DER.		SECOND DER.		
PEN UP	GO TO	IDENT.	FR	DOWN	FR	DOWN	FR	DOWN	FR	DOWN
6000.00000000	26.30897600	1.00000000	51.00	5000.00000000	1.00000000	51.00	11.48444700	-6.41741060	339	419
91.87558100		1.00000000	51.00	5000.00000000	5.98919990	51.00	8.57065670	-5.23775260	420	421
-205.35714000		1.00000000	51.00	5000.00000000	9.66896230	51.00	6.24669500	-4.05809450	422	423
201.32830000		1.00000000	51.00	5000.00000000	12.33419900	51.00	4.51256210	-2.87843650	424	425
-135.48370000		1.00000000	51.00	5000.00000000	14.27982800	51.00	3.36825850	-1.69877850	426	427
-66.08434000		1.00000000	51.00	5000.00000000	15.76768600	51.00	2.61532130	-1.31297040	428	429
1.97790700		1.00000000	51.00	5000.00000000	16.92730100	51.00	2.05528750	-0.92716218	430	431
-83343120		1.00000000	51.00	5000.00000000	17.85512500	51.00	1.68815800	-0.54135390	432	433
-12777800		1.00000000	51.00	5000.00000000	18.64761200	51.00	1.51393450	-0.15554578	434	435
-63787830		1.00000000	51.00	5000.00000000	19.38507800	51.00	1.43581060	-0.15695059	436	437
-13893454		1.00000000	51.00	5000.00000000	20.08330700	51.00	1.35698260	-0.15835523	438	439
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		1.00000000	51.00	5000.00000000	21.36062700	51.00	1.19722320	-0.16116468	442	443
		1.00000000	51.00	5000.00000000	21.93904800	51.00	1.11629050	-0.16256953	444	445
		1.00000000	51.00	5000.00000000	22.47680800	51.00	1.03465360	-0.16397265	446	447
		1.00000000	51.00	5000.00000000	22.97357500	51.00	.95231537	-0.16537734	448	449
		1.00000000	51.00	5000.00000000	23.42901200	51.00	.86927562	-0.16678234	450	451
		1.00000000	51.00	5000.00000000	23.84322900	51.00	.78843043	-0.16678234	452	453
		1.00000000	51.00	5000.00000000	24.21829100	51.00	.71267603	-0.16678234	454	455
		1.00000000	51.00	5000.00000000	24.55676300	51.00	.64201478	-0.16678234	456	457
		1.00000000	51.00	5000.00000000	24.86115300	51.00	.57644718	-0.16678234	458	
		1.00000000	51.00	5000.00000000	25.13405300	51.00	.51597311	-0.16678234		
		1.00000000	51.00	5000.00000000	25.37796800	51.00	.46059868	-0.16678234		
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FR	51.00	12.50000000	25.96123100	32377121	-.08000422	460
FR	51.00	13.00000000	26.11333000	28508910	-.07470347	461
FR	51.00	13.50000000	26.24675000	24905742	-.06940256	462
FR	51.00	14.00000000	26.36293700	21570122	-.06410024	463
FR	51.00	14.50000000	26.46287900	18496296	-.05879949	464
FR	51.00	15.00000000	26.54835300	15688517	-.05349872	465
FR	51.00	15.50000000	26.62024400	13145283	-.04819781	466
FR	51.00	16.00000000	26.68012900	10869345	-.04289705	467
FR	51.00	16.50000000	26.72931300	8837988	-.03834343	468
FR	51.00	17.00000000	26.76894600	7035236	-.03379138	469
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FR	51.00	18.50000000	26.84137800	2991033	-.02013348	472
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FR	51.00	19.50000000	26.86287500	1430272	-.01102921	474
FR	51.00	20.00000000	26.86881300	994561	-.00647715	475
FR	51.00	20.50000000	26.87289100	688654	-.00566110	476
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FR	51.00	21.50000000	26.87736700	204272	-.00403197	478
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FR	51.00	22.50000000	26.87764300	119803	-.00240142	480
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FR	51.00	31.00000000	26.79861500	5838094	-.03712884	497
FR	51.00	31.50000000	26.76523400	7850568	-.04332519	498
FR	51.00	32.00000000	26.72062200	10171395	-.04952156	499

1.6.0

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FR 76.50 1.50000000
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FR 76.50 2.50000000
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FR 76.50 3.50000000
FR 76.50 4.00000000
FR 76.50 4.50000000
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FR 76.50 11.50000000
FR 76.50 12.00000000

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22.90315700
23.37616600
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24.90927700
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SECOND DER.

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FR	76.50	14.50000000	26.89964400	19211052	-.06612289	545
FR	76.50	15.00000000	26.98762100	16026323	-.06124524	546
FR	76.50	15.50000000	27.06029000	13086677	-.05636601	547
FR	76.50	16.00000000	27.11882100	10390814	-.05148836	548
FR	76.50	16.50000000	27.16444000	07966141	-.04546439	549
FR	76.50	17.00000000	27.19886200	05843752	-.03944042	550
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FR	76.50	18.00000000	27.23975100	02502112	-.02739402	552
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FR	76.50	19.00000000	27.25288300	00364632	-.01534763	554
FR	76.50	19.50000000	27.25353200	00251287	-.00932364	555
FR	76.50	20.00000000	27.25094900	00567424	-.00330123	556
FR	76.50	20.50000000	27.24786500	00723282	-.00290797	557
FR	76.50	21.00000000	27.24406500	00858379	-.00251471	558
FR	76.50	21.50000000	27.23920100	00975216	-.00212300	559
FR	76.50	22.00000000	27.23403400	01070042	-.00172974	560
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FR	76.50	23.00000000	27.22258900	01192449	-.00094478	562
FR	76.50	23.50000000	27.21702200	01237506	-.00055150	563
FR	76.50	24.00000000	27.21006300	01258064	-.00015981	564
FR	76.50	24.50000000	27.20425300	01264598	-.00003602	565
FR	76.50	25.00000000	27.19789200	01265072	-.00008776	566
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FR	76.50	31.50000000	27.04261200	08126418	-.04086018	579
FR	76.50	32.00000000	26.99599300	10313029	-.04681662	580
PEN UP		6000.00000000				581

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1.5.0

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 FR 102.00 12.50000000

26.99599300

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FR 127.50	30.00000000	27.16011300	-.01857980	.00245120	738
FR 127.50	30.50000000	27.15122600	-.01687966	.00428365	739
FR 127.50	31.00000000	27.14341500	-.01427424	.00611761	740
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GO TO	1.00000000				744
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FR	25.50	27.50000000	26.31641500	.01386620	-.00502647	409
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FR	25.50	30.50000000	26.32905700	-.00718453	-.00891621	415
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FR	25.50	31.50000000	26.31771600	-.01668842	-.01018371	417
FR	25.50	32.00000000	26.30897600	-.02200137	-.01081825	418

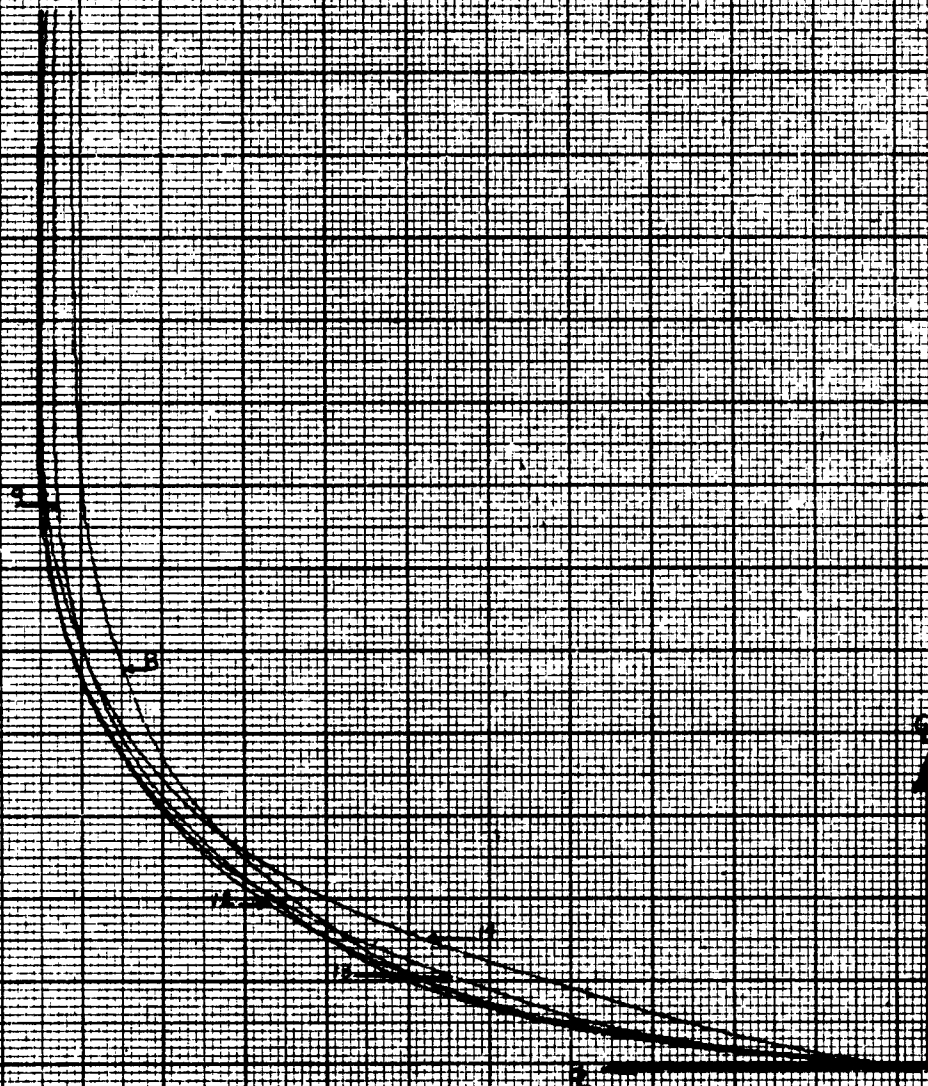


Fig. 2.5. Outer Center Stations

Scale: 1" = 5.0'

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STERN SURFACE OF DLG-26

Project:

To fair a portion of the stern of the DLG-26, including the stern proville. This surface extends from Station 14 to Station 18 and is extremely complex. The surface includes the transition from the middlebody to the area encompassing the stern profile.

Data:

The preliminary offsets of Stations 14 through 18 on waterlines at four-foot intervals beginning at the baseline and extending to the thirty-two-foot waterline. Also, a set of offsets describing the profile of the stern runup which was scaled from the preliminary lines plans.

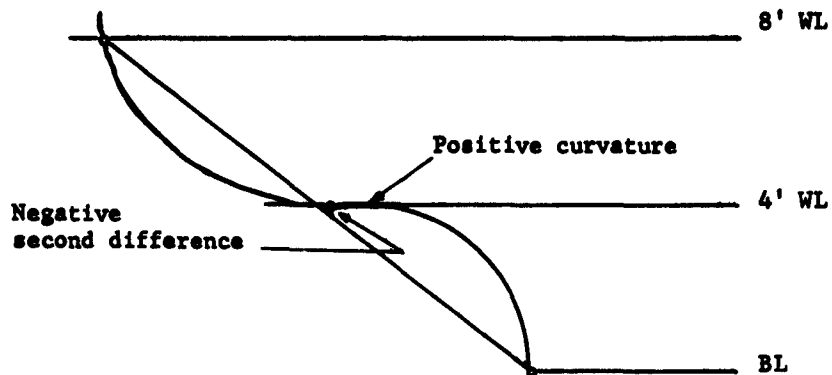
Procedure:

The first step was to fair the two-dimensional stern profile and obtain its faired equation on the IBM-1620. This equation, along with the preliminary offsets, were entered into SMOG-2 which punched the LP matrix on the IBM-1620 in the dual-lambda formulation using double spline in the X direction only. The results were solved for using GOBACK-2 and the offsets plotted as shown.

Results:

The upper portion of the surface faired quite well. However, the lower section which represents the largest portion of the surface appears to be quite unfair. In analyzing the results, two predominant reasons for this result were found:

1. The equation for the profile was found to contain an inflection point in the first interval and therefore did not accurately represent the profile.
2. A condition was found where the sign of the second difference at a given offset as calculated from the neighboring offsets was opposite in sign from the desired curvature. This is illustrated below.



The signs, however, were consistent with neighboring signs and therefore were not detected by the smoothing routine.

The surface meets all of the conditions which were required, including those in error, and λ equaled .02'.

Recommendations:

It is recommended that the surface be re-faired incorporating the following improvements:

1. Re-fair the profile to obtain an accurate equation
2. Manually set the erroneous signs of the second differences to their proper values
3. Include the two-foot waterline in the data to help define this portion of the surface

With these changes, a satisfactory surface should result.

DLG	26	STERN	5 STA	14	TO	18
-1	1	.25	30.			
10	5	0.001	1000.	3.		.33333333
1.5294						
.5060						
-2.1136						
.4784						
0.0						
0.0						
-.2528						
0.0						
0.0						
0.0						
0.0						
0.0						
0.0						
.0000						
1.0000		.000000				
1.5000		.000000				
2.0000		1.000000				
2.5000		1.000000				
3.0000		1.000000				
0.25						
1.000		0.0				
1.5		0.0				
2.0		1.000				
2.5		1.2396				
3.0		3.5208				
.5000						
1.0000		.000000				
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3.0000		10.197916				
1.0000						
1.0000		.000000				
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2.5000		16.333333				
3.0000		20.281250				
1.5000						
1.0000		7.729166				
1.5000		16.000000				
2.0000		20.770833				
2.5000		23.250000				
3.0000		24.718749				
2.0000						
1.0000		19.000000				

1.5000	22.083333
2.0000	24.208332
2.5000	25.510416
3.0000	26.354166
2.5000	
1.0000	20.28161
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2.0000	24.843749
2.5000	26.031250
3.0000	26.760416
3.0000	
1.0000	20.647778
1.5000	23.177082
2.0000	24.968749
2.5000	26.124999
3.0000	26.822916
3.5000	
1.0000	20.834333
1.5000	23.312500
2.0000	25.052083
2.5000	26.177082
3.0000	26.822916
4.0000	
1.0	20.92268
1.5	23.36458
2.0	25.11458
2.5000	26.208332
3.0000	26.791666
0.5	1.0

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0.0

DLG 26 FIRED OFFSETS STERN STATIONS 14 TO 18

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-322.22542225
-483.26606720
264.84603999
-33.50312000
-7.90164000
-42938000
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FR 0.00	18.00000000	20.00113073	.26938006	-.18016289
FR 0.00	19.00000000	20.19544294	.13425789	-.09008144
FR 0.00	20.00000000	20.29967366	.08921717	0.00000000
FR 0.00	21.00000000	20.38847158	.08795922	-.00251590
FR 0.00	22.00000000	20.47475348	.08418538	-.00503179
FR 0.00	23.00000000	20.55600364	.07789562	-.00754769
FR 0.00	24.00000000	20.62970611	.06908999	-.01006359
FR 0.00	25.00000000	20.69418361	.06028433	-.00754769
FR 0.00	26.00000000	20.75111339	.05399459	-.00503180
FR 0.00	27.00000000	20.80301130	.05022074	-.00251590
FR 0.00	28.00000000	20.85239352	.04896278	0.00000000
FR 0.00	29.00000000	20.89911208	.04223018	-.01346519
FR 0.00	30.00000000	20.93236532	.02203238	-.02693039
FR 0.00	31.00000000	20.93868847	-.01163059	-.04039558
FR 0.00	32.00000000	20.90461592	-.05875877	-.05386078
PN UP	6000.00000000			
GO TO	9.33789062	20.90461592		
	.87355375			

1.5.0

206.11363832
-634.62366971
500.59132277
-558.19999101
20.65268813
48.01930079
-5.07086936
-5.99245133
.00000001
-1.24476003

IDENT.	Z
FR 1.00	5.65478515
PN DOWN 5000.00000000	
FR 1.00	6.65478515
FR 1.00	7.65478515
FR 1.00	8.00000000
FR 1.00	9.00000000
FR 1.00	10.00000000
FR 1.00	11.00000000
FR 1.00	12.00000000
FR 1.00	13.00000000
FR 1.00	14.00000000
FR 1.00	15.00000000
FR 1.00	16.00000000
FR 1.00	17.00000000
FR 1.00	18.00000000
FR 1.00	19.00000000
FR 1.00	20.00000000
FR 1.00	21.00000000
FR 1.00	22.00000000
FR 1.00	23.00000000
FR 1.00	24.00000000
FR 1.00	25.00000000
FR 1.00	26.00000000
FR 1.00	27.00000000
FR 1.00	28.00000000
FR 1.00	29.00000000
FR 1.00	30.00000000
FR 1.00	31.00000000
FR 1.00	32.00000000
PN UP 6000.00000000	

Y	1ST DER.	2ND DER.
0.00000000	0.00000000	0.00000000
.93631875	.63372656	1.83558658
2.37744157	2.13653311	1.16587733
3.17984625	2.49878424	.93282225
6.07286197	3.21506755	.49974436
9.46562206	3.49827296	.06666646
12.92504860	3.34840048	-.36641142
16.01806373	2.76545011	-.79948931
18.40537726	2.03078495	-.66984102
20.12284973	1.42576806	-.54019273
21.30012949	.95039947	-.41054444
22.06686478	.60467917	-.28089615
22.54279990	.35889503	-.21067211
22.80806289	.18333493	-.14044808
22.93287779	.07799887	-.07022404
22.98746863	.04288684	0.00000000
23.03035552	.04288685	0.00000000
23.07324235	.04288685	0.00000000
23.11612916	.04288685	0.00000000
23.15901602	.04288683	0.00000000
23.20190289	.04288684	0.00000000
23.24478987	.04288685	0.00000000
23.28767656	.04288683	0.00000000
23.33056343	.04288683	0.00000000
23.37101918	.03559333	-.01458703
23.39688765	.01371275	-.02917406
23.39358238	-.02275480	-.04376109
23.34651573	-.07380942	-.05834812

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1.5.0

GO TO 5.65478515
 .98193625
 12.40774233
 -55.50853650
 63.59176373
 -90.17783653
 12.87245998
 25.36495657
 -10.04310612
 -1.15420630
 -.45403130
 -.53987434

IDENT. Z
 FR 2.00 0.00000000
 PN DOWN 5000.00000000
 FR 2.00 1.00000000
 FR 2.00 2.00000000
 FR 2.00 3.00000000
 FR 2.00 4.00000000
 FR 2.00 5.00000000
 FR 2.00 6.00000000
 FR 2.00 7.00000000
 FR 2.00 8.00000000
 FR 2.00 9.00000000
 FR 2.00 10.00000000
 FR 2.00 11.00000000
 FR 2.00 12.00000000
 FR 2.00 13.00000000
 FR 2.00 14.00000000
 FR 2.00 15.00000000
 FR 2.00 16.00000000
 FR 2.00 17.00000000
 FR 2.00 18.00000000
 FR 2.00 19.00000000
 FR 2.00 20.00000000
 FR 2.00 21.00000000
 FR 2.00 22.00000000
 FR 2.00 23.00000000
 FR 2.00 24.00000000
 FR 2.00 25.00000000
 FR 2.00 26.00000000

23.34651573

Y
 .98193625
 1.78978582
 1.60820960
 1.18242359
 1.25764375
 2.40295749
 4.48293784
 7.18602927
 10.20067624
 13.24046473
 16.11954681
 18.67721609
 20.75276617
 22.23503158
 23.21101056
 24.19026601
 24.44700540
 24.62592246
 24.74586373
 24.82567572
 24.88195069
 24.92226361
 24.95193517
 24.97628602
 24.99975011
 25.02321418

1ST DER.
 1.55096779
 .18893401
 -.42788377
 -.29948559
 .57412857
 1.66457296
 2.44346181
 2.91079512
 3.06657289
 2.98621968
 2.74516008
 2.34339407
 1.78092167
 1.20636566
 .76834883
 .46687119
 .30193273
 .21468713
 .14628807
 .09673554
 .06602954
 .04740716
 .03410545
 .02612442
 .02346407
 .02346407
 .02346406

2ND DER.
 -1.73464176
 -.98942578
 -.24420980
 .50100617
 1.24622215
 .93466661
 .62311107
 .31155553
 0.00000000
 -.16070640
 -.32141280
 -.48211920
 -.64282560
 -.50628641
 -.36974723
 -.23320805
 -.09666886
 -.07782233
 -.05897579
 -.04012926
 -.02128272
 -.01596204
 -.01064136
 -.00532068
 0.00000000
 0.00000000
 0.00000000

FR	2.00	27.00000000	25.04667824	.02346405	0.00000000
FR	2.00	28.00000000	25.07014226	.02346404	0.00000000
FR	2.00	29.00000000	25.09255188	.02030071	-.00632665
FR	2.00	30.00000000	25.10863482	.01081072	-.01265331
FR	2.00	31.00000000	25.11206446	-.00500590	-.01897996
FR	2.00	32.00000000	25.09651413	-.02714919	-.02530661
PN UP	6000.00000000				
GO TO	0.00000000		25.09651413		

1.01806375
 -31.48543984
 114.73951458
 -76.49300981
 68.28910003
 9.51247788
 3.83294821
 -3.68263027
 -1.16394716
 -.43257891
 .27528031

IDENT.	Z	Y	1ST DER.	2ND DER.
FR	3.00	1.01806375	-3.93567998	3.58560983
PN DOWN	5000.00000000			
FR	3.00	1.27421172	-.79827137	2.68920737
FR	3.00	.87727982	1.44273476	1.79280491
FR	3.00	1.31245698	2.78733844	.89640245
FR	3.00	4.39859624	3.23553967	0.00000000
FR	3.00	7.61811265	3.18746988	-.09613957
FR	3.00	10.74148949	3.04326052	-.19227913
FR	3.00	13.67258719	2.80291160	-.28841870
FR	3.00	16.31526618	2.46642311	-.38455827
FR	3.00	18.59196595	2.08953223	-.36922349
FR	3.00	20.49944223	1.72797612	-.35388871
FR	3.00	22.05302980	1.38175480	-.33855392
FR	3.00	23.26806345	1.05086827	-.32321914
FR	3.00	24.16736417	.75777519	-.26296700
FR	3.00	24.80369789	.52493427	-.20271485
FR	3.00	25.23731676	.35234548	-.14246271
FR	3.00	25.52847291	.24000884	-.08221056
FR	3.00	25.73022586	.16634643	-.06511424
FR	3.00	25.86686456	-.10978035	-.04801792
FR	3.00	25.95548533	.07031058	-.03092160

1.5.0

FR	3.00	20.00000000	26.01318450	.04793713	-.01382528
FR	3.00	21.00000000	26.05478504	.03584000	-.01036897
FR	3.00	22.00000000	26.08601662	.02719919	-.00691265
FR	3.00	23.00000000	26.11033554	.02201469	-.00345634
FR	3.00	24.00000000	26.13119812	.02028651	-.00000002
FR	3.00	25.00000000	26.15121578	.01948000	-.00161299
FR	3.00	26.00000000	26.16962048	.01706052	-.00322596
FR	3.00	27.00000000	26.18479919	.01302807	-.00483893
FR	3.00	28.00000000	26.19513899	.00738266	-.00645190
FR	3.00	29.00000000	26.19956451	.00173724	-.00483892
FR	3.00	30.00000000	26.19915114	-.00229519	-.00322595
FR	3.00	31.00000000	26.19551178	-.00471466	-.00161298
FR	3.00	32.00000000	26.19025945	-.00552116	-.00000001
PN UP	6000.00000000				
GO TO	0.00000000				
	.98193625				
	67.22258729				
	-172.85596836				
	150.69388729				
	-206.23405160				
	75.62375268				
	-22.41655973				
	4.45348728				
	-1.90806060				
	-.21245508				
	-.68279180				

IDENT.		Z	Y	1ST DER.	2ND DER.
FR	4.00	0.00000000	.98193625	8.40282341	-5.40174901
PN DOWN	5000.00000000				
FR	4.00	1.00000000	6.97820915	3.88404639	-3.63580501
FR	4.00	2.00000000	9.33867703	1.13121337	-1.86986102
FR	4.00	3.00000000	9.82928389	.14432434	-.10391703
FR	4.00	4.00000000	10.21597371	.92337929	1.66202695
FR	4.00	5.00000000	11.86188961	2.25997560	1.01116565
FR	4.00	6.00000000	14.51897115	2.94571060	.36030435
FR	4.00	7.00000000	17.53635706	2.98058431	-.29055694
FR	4.00	8.00000000	20.26318602	2.36459671	-.94141824
FR	4.00	9.00000000	22.19629937	1.54085574	-.70606369
FR	4.00	10.00000000	23.42334903	.95246932	-.47070914
FR	4.00	11.00000000	24.17968954	.59943745	-.23535459
FR	4.00	12.00000000	24.70067546	.48176014	-.00000004

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FR	4.00	13.00000000	25.17787899	.46809034	-.02733954
FR	4.00	14.00000000	25.62774298	.42708104	-.05467905
FR	4.00	15.00000000	26.02292791	.35873223	-.08201856
FR	4.00	16.00000000	26.33609427	.26304390	-.10935807
FR	4.00	17.00000000	26.54860077	.16611073	-.08450827
FR	4.00	18.00000000	26.67659900	.09402735	-.05965848
FR	4.00	19.00000000	26.74493875	.04679376	-.03480868
FR	4.00	20.00000000	26.77846979	.02440997	-.00995889
FR	4.00	21.00000000	26.79831528	.01569594	-.00746917
FR	4.00	22.00000000	26.81069160	.00947161	-.00497946
FR	4.00	23.00000000	26.81808844	.00573700	-.00248975
FR	4.00	24.00000000	26.82299551	.00449210	-.00000004
FR	4.00	25.00000000	26.82748761	.00449205	-.00000004
FR	4.00	26.00000000	26.83197964	.00449201	-.00000004
FR	4.00	27.00000000	26.83647163	.00449197	-.00000003
FR	4.00	28.00000000	26.84096356	.00449193	-.00000003
FR	4.00	29.00000000	26.84412193	.00449116	-.00800149
FR	4.00	30.00000000	26.83927876	-.01151106	-.01600296
FR	4.00	31.00000000	26.81843265	-.03151476	-.02400042
FR	4.00	32.00000000	26.77358210	-.05951991	-.03200589
PN UP		6000.00000000			
GO TO		0.00000000	26.77358210		

